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## *THE ENDOWMENT OF ASTRONOMICAL RESEARCH.*

THE unexampled prosperity of the United States, during the past few years, has given it the industrial supremacy of the world in many departments. A similar advance is to be expected in its scientific progress, especially in astronomy, if equal skill is shown in organization and development. The vast fortunes now being accumulated must, during the next few years, lead to gifts and endowments on a scale unparalleled in the past. It is not an easy matter to make large gifts wisely, and probably many of the most brilliant men in the country, having amassed large fortunes, are now trying to decide how they can bestow them to the best advantage. To establish a university of the highest grade a large sum of money is required. For instance, Harvard for many years has had an annual income exceeding a million dollars. To duplicate

the buildings, collections and other parts of the permanent plant, many millions would be needed to equal it even pecuniarily. Even then, a rival institution would be established, which might do more harm than good, since it would draw its students mainly from those who would otherwise go to existing universities.

Astronomy is a science which has always received a large share of such gifts as those mentioned above. Its rapid growth, at the present time, and the brilliant results obtained by the application of photography, spectroscopy and other branches of astrophysics, render it probable that it will still further attract the patrons of science. Unfortunately, in the past, many gifts have been made to astronomy which have not yielded the results expected from them. Thus we had at one time in the United States a great observatory, but no telescope; a great telescope, but no astronomer to use it; and an astronomer whose valuable observations, the results of many long years of hard work, were rendered useless by the lack of a few hundred dollars to publish them. We have still many beautiful observatories, equipped with powerful and expensive telescopes which are idle, and therefore useless, during a large part of the night. These unfortunate results are largely due to lack of consultation with astronomers by prospective donors. Consequently, many gifts have been made from which little return has been obtained.

While, as shown above, there are but few persons with fortunes large enough to establish a university of the first class, a much smaller sum would be required to establish an astronomical institution, whose usefulness would far exceed that of any now existing, especially by utilizing the plant already collected. The five observatories having the largest annual incomes are the U. S. Naval Observatory, $85,000; Paris, $53,000; Greenwich, $49,000; Polkowa, $48,000; Harvard, $50,000. The permanent endowment of the Harvard Observatory has increased from $176,000 to $909,000 during the last quarter of a century. These funds are invested by the treasurer of the university, together with the other funds in his charge, which now exceed $14,000,000. This large sum permits a very advantageous investment to be made, and during the last year the net rate of interest, free from all taxes, has amounted to four and eight tenths per cent. The age of the university, two hundred and sixty-seven years, insures great permanency in its management. It has passed uninjured through the periods of two great wars, and the great fire of Boston in 1872, which was still more disastrous to its supporters. Although the citizens of Boston lost many millions of dollars in this fire, this did not prevent their making good the heavy losses of the university. The strong interest and support of the people of eastern Massachusetts, which has led to their giving many million dollars to Harvard, is the best assurance that money intrusted to it will be spent as the donors wish.

It is estimated that the total sum spent yearly on astronomical research throughout the world amounts to about $500,000. It has been pointed out by Professor Newcomb that an addition to this sum of even $100,000, distributed among existing observatories, might increase the amount of work done, but would not necessarily improve its quality. Owing to the great industrial prosperity of this country, gifts may be expected ten times as large as those of the last century, during which this observatory received three funds exceeding one, two and three hundred thousand dollars, respectively. This seems, therefore, a proper time to consider how a gift of one

or two million dollars, if given to Harvard for astronomical purposes, could be best expended, and to see if the advantages would not prove so great as to induce some lover of science to make this gift. The great sums expended on astronomy in the past have developed elaborate systems of work and expensive instruments, such as have not been furnished in any other science, and have given astronomers a training in carrying on work on a scale not attempted in the other sciences. This, however, renders it necessary to expend large sums in order to attain better results than are now secured, and to make a real advance. It should be pointed out that it is as important to prevent gifts under improper restrictions, as to secure those that can be wisely expended. In the first case, not only is no useful result attained, but other donors are discouraged by seeing money thus wasted. It is also a matter of the greatest importance that the donors should see and appreciate the results attained, so that they may in this way receive a partial return for their enlightened generosity.

The policy of this observatory has been to secure and retain the interest of donors, and, when beginning on a small scale, to obtain results that justified extension. Thus, in 1882, an appropriation of $500 was secured from the Rumford fund, for investigations in astronomical photography. With this a camera of two and a half inches aperture was purchased, and stellar photographs taken, which led to an appropriation of $3,000 from the Bache fund. An eight-inch photographic telescope was procured, and with this thirty thousand $8 \times 10$ photographs have been taken. After being used on the northern stars in Cambridge, this instrument was sent to Arequipa, Peru, where it is now used throughout every clear night. The results proved of such value that Mrs. Henry Draper gave a second eight-inch doublet, to replace the Bache telescope in Cambridge. Thirty thousand photographs have been taken with this instrument also. Again the results were used to secure a still larger instrument, and, in 1889, Miss C. W. Bruce gave $50,000 for the construction of a twenty-four-inch photographic doublet, the most powerful instrument of the kind in the world. This instrument is also in successful use at Arequipa. As the photographs increased rapidly in number, the room for their storage and examination proved wholly insufficient. Again the friends of the observatory came forward and provided it with an adequate fire-proof building for their accommodation. Finally, this last year a grant from the Carnegie Institution has given us the means of beginning a systematic study of these plates, and thus extracting a few of the vast multitude of facts accumulated on them.

The three principal sources of income of the observatory, the Paine fund, the Boyden fund and the Henry Draper memorial, were all received after arguments had been presented showing the results obtained on a small scale. Fortunately no restriction was attached to either of these gifts that would interfere with its usefulness, and the income of the observatory can be expended in almost any way that will secure the greatest scientific return.

Another policy of the observatory has been one of cooperation, the last example being in determining the brightness of a system of standards of magnitudes for very faint stars. By the help of an appropriation of $500 from the Rumford fund, suitable photometers have been devised and constructed, and the directors of the Yerkes, Lick and McCormick observatories have courteously cooperated with us, so

that a system of standard stars has been selected and measured, including some of the faintest stars visible in the largest telescopes. In this work, telescopes of 40, 36, 26, 15 and 12 inches aperture, including the two largest telescopes in the world, are working together.

It is also our policy to carry on work in whatever way the greatest scientific return can be secured, whether at Cambridge or elsewhere. A fund of $70,000, of which $10,000 is now available, has been given for this purpose. It may be claimed that it will be difficult to maintain permanently a policy of complete unselfishness, by which astronomers in other countries may be aided whenever they can do a given work better than we can. The answer to this is that no body of trustees is better qualified to enforce such a policy than the president and fellows of Harvard College. Apart from the broad views they have always maintained, it is obvious that they could never afford, with the great interests they have at stake, to fail to carry out the wishes of any donor.

In 1886 a pamphlet, entitled 'A Plan for the Extension of Astronomical Research,' was published by the writer. As a result, in 1890 the sum of six thousand dollars was given by Miss C. W. Bruce, to try the plan for one year, and, out of eighty-six applications, it was distributed as follows:

3. Professor W. W. Payne, Director of the Carleton College Observatory. Illustrations of the Sidereal Messenger.

6. Professor Simon Newcomb, Superintendent of the American Nautical Almanac. Discussion of contact observations of Venus during its transits in 1874 and 1882.

16. Dr. J. Plassmann, Warendorf. For printing observations of meteors and variable stars.

23. Professor H. Bruns, Treasurer of the Astronomische Gesellschaft. To the Astronomische Gesellschaft for the preparation of tables according to Gyldén's method for computing the elements of the asteroids.

27. Professor J. J. Astrand, Director of the Observatory, Bergen, Norway. Tables for solving Kepler's Problem.

29. Professor J. C. Adams, Director of the Cambridge Observatory, England. Spectroscope for the 27-inch telescope of the Cambridge Observatory.

36. Professor A. Hirsch, Secretary of the International Geodetic Association. To send an expedition to the Sandwich Islands to study the annual variation, if any, in latitude.

40. H. H. Turner, Esq., Assistant in Greenwich Observatory. Preparing tables for computing star corrections.

45. Professor Edward S. Holden, Director of the Lick Observatory. Reduction of meridian observations of Struve stars.

46. Professor Lewis Swift, Director of the Warner Observatory. Photographic apparatus for 15-inch telescope.

54. Professor Norman Pogson, Director of Madras Observatory. Publication of old observations of variable stars, planets and asteroids.

57. Dr. Ludwig Struve, Astronomer at Dorpat Observatory. Reduction of observations of occultations during the lunar eclipse of January 28, 1888, collected by the Pulkowa Observatory.

60. Dr. David Gill, Director of the Observatory of the Cape of Good Hope. (1) Reduction of heliometer observations of asteroids. (2) Apparatus for engraving star charts of the Southern Durchmusterung.

78. Professor A. Safarik, Prague. Photometer for measuring variable stars.

79. Professor Henry A. Rowland, Johns Hopkins University. Identification of metals in the solar spectrum.

These examples show how high a grade of application might be expected, and, of course, if successfully carried out, the quality of the work would continually improve.

The following outline of a plan will show how a sum of fifty to one hundred thousand dollars annually could be advantageously expended for astronomy by this observatory. A board of advisers, consisting of several of the leading astronomers of the country, would be appointed, who would meet once a year, or at first oftener, to consider how the available income could

be best expended in order to receive the greatest scientific return.

This board would consist partly of the directors of observatories who could expend portions of the income themselves, and partly of older astronomers who, having retired from active work, could decide without prejudice how the income could be expended to the best advantage by others. They would have authority to add temporarily to their number, astronomers who might be invited to participate in any special work, and who could thus take part in their discussions on equal terms. All expenses of this board would be paid from the income, and except for clerk hire these would be almost the only executive expenses. A circular letter would be sent to all astronomers, inviting application for aid and suggestions for methods of expending the income. If possible, close relations would be established with the trustees of all the research funds which could be used for astronomical purposes, to increase efficiency and avoid duplication of work. The most important duty of the board of advisers would be to consider each year what departments of astronomy were being neglected, and to secure the needed observations, or, if necessary undertake them themselves, or see that they were made at Harvard. As every astronomer is inclined to undertake the work which attracts him most, especially interesting investigations are likely to be duplicated unnecessarily, while laborious or unattractive investigations are neglected. This is particularly objectionable, since in astronomy, a science of observation and not of experiment, an opportunity once missed can in many cases never be recovered. As an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but so far as known only two or three have made the reductions needed to render their observations of any value. When a plan was decided on it would be discussed by the entire board, and it is obvious that their combined experience would render serious mistakes less probable than when all depends on the judgment of a single individual, as is now the case. They could find the best man for a given research, and give him the best possible facilities for carrying it on. They could undertake larger and more difficult researches than a single observatory could attempt. It would be the power of many, instead of one, and of large, instead of restricted, resources. The opportunity offered to such a board of advisers, having control of the principal instruments of the country and a large sum of money available to set at work any particular corps of astronomers, ought to secure results far beyond those attainable at any existing observatory. All the advantages of a trust would be secured, with none of its objections. No one could object to a trust in wheat, for example, if its only object was to increase the quality and quantity of the crop, and to furnish it to consumers at the lowest rates, also to aid those not members of the trust in every possible way. In the present case, these conditions would be enforced by a body of men entirely unprejudiced, the corporation of Harvard College. It is universally admitted that in the industrial arts there is a great advantage in cooperation, and in carrying on work on a very large scale. The same remarks apply to scientific investigation, with the added advantage that the supply and demand are indefinitely great, so that the market can never be glutted.

Apart from the advantages to astronomy of such a plan as is here outlined, it is believed that it would serve as a valuable example to the other sciences, and the moral effect of promoting uniformity of purpose,

and friendly aid to one another, by astronomers of all countries, would encourage other donors. An incidental advantage of this plan is that it could be tried on a small scale, as for a single year, and the donor could thus see what results were likely to follow if he made the plan permanent.

Of course, every effort would be made to establish the closest relations with astronomers in general, as the object of the institution could not be attained if the work done was not regarded as advancing astronomical research in the best way. Much might be accomplished through existing societies and periodicals. Another matter of especial importance is that when an astronomer is aided who is qualified to carry on work in the best way, no restrictions should be made on the appropriation, which would in any way interfere with his obtaining the best results.

It will be noticed that this plan differs from those governing existing funds for research, in being active and not passive. While the trustees of other funds wait for applications, and then consider what appropriations can be made, it would be the aim of the advisers of this fund to learn what astronomers desired aid, what instruments now unused were available for work, and what valuable material remained unpublished, and consequently useless, for lack of means. Its special object would be to determine the needs of astronomers, to find what subjects were being neglected, especially those whose usefulness would be lost by delay, and, if possible, to take the necessary steps to secure their execution. Much might be done with existing funds, and it is believed that the trustees of such funds would, in many cases, welcome the means of expending the available income to the best advantage. The opportunities for good work are far in excess of the present means for supplying them. Even the great resources of the Carnegie Institution will be able to respond to only a portion of the excellent applications made to it for aid.

It is most important that unnecessary delays should be avoided. It often happens that an astronomer could undertake a piece of work at once, perhaps during a summer vacation, while after a delay of several months he might be unable to carry it out, or might have lost many of the details then fresh in his mind. This is still more important with large pieces of work. A delay of several years may render a mature astronomer incapable of completing a work which, if undertaken at once, he could carry out with his greatest vigor and skill.

These remarks apply with equal force to the present plan of work. The Harvard Observatory has now the appliances, both intellectual and physical, for undertaking large pieces of work. Several of the leading astronomers of the country are in sympathy with such a plan for cooperation, so that the important methods of organizing and initiating a system could be devised at the present time under very favorable conditions, which may not prevail a few years hence, although the plan, once started, could easily be carried on by others. It therefore seems wise to make a beginning, however small, hoping to show results that will lead to an early fulfilment of the entire plan.

The undersigned, therefore, invites the astronomers of this and other countries to send to him applications for aid. A brief statement of the case in form for publication should be made, generally not exceeding two hundred words in length, with an estimate of the cost, and any additional necessary details. If publication is not desired, it should be stated.

The undersigned will then use his best efforts to secure the execution of such of

these plans as commend themselves to him, reserving the right to omit all others. If the list of applications received seems worthy of it, he will publish and distribute it to possible donors, and will endeavor to secure its publication elsewhere. He will also bring such applications as commend themselves to him to the attention of the officers in charge of the following research funds, with which he is officially connected:

Rumford Fund of the American Academy. Principal, $52,000. Income available to aid American investigators in light and heat.

Elizabeth Thompson Science Fund. Principal, $26,000. Income available for investigators of all countries in all departments of science. Appropriations seldom exceed $300.

Henry Draper Fund of the National Academy. Principal, $6,000. Accumulated income April 15, 1902, $1,515.99. Available for investigations in astronomical physics, by citizens of the United States.

Advancement of Astronomical Science Fund of the Harvard College Observatory. Principal, $70,000, of which $10,000 is now available as stated above. Income may be used for astronomers of any country.

When we consider the great sums at the disposal of the trustees of the Carnegie Institution, and the large unexpended balances of the various research funds of the National Academy, it is not probable that any really worthy investigation requiring only a few hundred dollars for its execution need fail for want of such a sum.

There is another direction in which the writer believes that a great astronomical return could be obtained for a reasonable expenditure of money, some of which is already available. There are, in the United States, many telescopes of large size, which are now in use during only a small portion of every clear night. It is believed that in many cases advanced students in astronomy would be glad to undertake systematic observations with such instruments, for a salary equivalent to a fellowship. They would thus be enabled to continue their studies, and at the same time make valuable additions to our knowledge of astronomy.

Larger investigations may be carried on by the Carnegie Institution, or by private gift. For such investigations the undersigned offers assistance to prospective donors, *if they desire it.* He will, in that case, secure for them the opinions of the leading astronomers of the country, regarding any proposed investigation. A wealthy man, when making a large investment in an industrial enterprise with which he is not familiar, would always obtain the opinion of an expert, for which he would often pay a large sum. How much more important is it in a subject like astronomy, with which he is likely to be still less familiar, that he should learn the views, which would be given freely and without charge, of the principal experts in the country who have devoted their entire lives to the consideration of these subjects.

It is believed that there are many cases where great results could be obtained from a relatively small expenditure. This is illustrated by the following examples:

*A Northern Photographic Durchmusterung.*—One of the greatest astronomical enterprises of the nineteenth century was the 'Northern Durchmusterung' of Argelander. This consists of a catalogue giving the approximate places and magnitudes of 324,189 stars, north of declination $-2°$, or practically north of the equator. This has been extended by his successor, Schönfeld, to declination $-23°$, including 133,659 stars, and successively to $-32°$, 179,800 stars, $-42°$, 160,415 stars, and $-52°$, 149,447 stars, by Thome at the Cordoba Observatory, where its extension to the South Pole is now in progress. Meanwhile, photographs taken by Gill at the Cape of

Good Hope have been measured by Kapteyn, and have given us the 'Cape Photographic Durchmusterung,' which contains 454,875 stars from $-19°$ to the South Pole. The errors in right ascension, of the positions in the Durchmusterungs of Argelander, Schönfeld and Thome, are about 9″, 6″ and 7″, respectively. The corresponding errors in declination are 26″, 10″ and 14″. The errors in the 'Cape Durchmusterung' are only about 3″ in each coordinate.

Professor Kapteyn, notwithstanding the long and laborious work he did gratuitously on the 'Cape Durchmusterung,' is willing to undertake the supervision of a similar catalogue of the northern stars, thus completing the work for the entire sky. Of course his past experience renders him the one man especially fitted for this work, which he could carry out in Holland so economically that it is probable the work could be completed by the expenditure of $25,000 during the next ten years.

The catalogue would contain about 900,000 stars, and would occupy ten quarto volumes of 300 pages each. Professor Kapteyn also believes that with a new measuring engine, which would cost $2,000, the errors could be reduced from 3″ to 1″. The cost of reduction would thus be increased, but by an amount which could be closely estimated before the work was undertaken. This is perhaps the most advantageous expenditure of money for astronomical purposes that can be made at the present time. The donor would be sure of the constant remembrance and gratitude of future astronomers. The matter is so important that this observatory would undertake to contribute without charge all the photographs needed, as its share of the enterprise.

As another illustration, the Georgetown College Observatory is about to establish a southern station in Rhodesia, South Africa. Father Goetz, S.J., will take charge of this work, and is now on his way. For $3,000 a twelve-inch telescope can be purchased, mounted and used, so that the excellent catalogues and charts of variable stars, completed for northern regions by Father Hagen, could be extended to the South Pole. As the cost of a first-class twelve-inch lens alone is about $3,000, we may regard the mounting, observatory and time of the observer as gratuitous contributions.

If donors could be found who would carry out such schemes as these, it is believed that the supremacy of the United States in astronomy might be placed on a foundation as secure as its industrial supremacy is in any department of work.

In brief, it is proposed to establish an institution in connection with the Harvard Observatory, whose aim should be to advance astronomy as much as possible by making appropriations under the combined advice of the leading astronomers of the country. Much attention would be paid to neglected subjects, especially to those which can not be provided for by later observations, to secure for persons properly qualified the use of powerful telescopes now idle and therefore useless, and, in general, to secure for the person best qualified for any given research the best possible means of carrying it on. It would provide means for cooperation, and would aim at the advancement of astronomy, regardless of country or any personal considerations. The cost of this plan, if fully carried out, would be less than that of a first-class observatory, and it could be fairly tried for a short time, at a moderate expense. For success, it must be wholly unselfish, and, this condition permanently secured, the

investments must be safe and the net income large. It is believed that no guardian would more surely fulfill these conditions than the corporation of Harvard College.

EDWARD C. PICKERING.

CAMBRIDGE, MASS.,
April, 1903.

## *THE NATURE OF NERVE IRRITABILITY, AND OF CHEMICAL AND ELECTRICAL STIMULATION. PART II.*

THE present paper contains results confirming and extending those given in my paper in SCIENCE, Vol. XV., pp. 492–498, 1902. The results previously reported were interpreted to mean that chemical stimulation by salts, apart from the osmotic stimulation of strong solutions, was really an electrical stimulation due to the electric charges of the dissociated ions. Of these ions the negative or anion always tended to stimulate the nerve, while the positive or cathion always tended to reduce nerve irritability and prevent stimulation. Whether any salt stimulated or annihilated nerve irritability without stimulation depended upon the predominance of the anion or the cathion. Chemical stimulation was shown to be in reality electrical, instead of electrical stimulation being chemical as had hitherto been supposed. These results made it possible to understand electrotonus and electrical stimulation. The cathode increases nerve irritability and stimulates, because in this region anions are predominant during the passage of the current; while the anode depresses because here the cathions preponderate. Stimulation on the break of the current was due to the reverse of these processes, the accumulated anions diffusing toward the cathions, and a fall in the positivity of the nerve in the anode region resulting. Furthermore, the specific action of the ions upon the nerve was supposed to be due to a production of a change in state in the colloids in the nerve, extending Loeb's hypothesis in this particular and making it specific that stimulation meant a precipitation of the colloids, inhibition the reverse; the colloids of the motor nerve reacting as if they were electro-positive.

Since the publication of this paper, illness and the pressure of other work have prevented my bringing the matter to a conclusion as soon as I had hoped, and meantime Loeb has published an attack on my hypothesis so far as it applies to muscle.*

Loeb has been led to abandon this hypothesis because of certain exceptions, among them being the action of barium chloride. Further work, of which the following is a preliminary statement, establishes, I believe, the truth of the main conclusions in my former paper, so far at least as motor nerves are concerned. In the case of the muscle I can not but think, from Loeb's results, that a careful study of apparent exceptions might show the same facts there, and explain these exceptions, as has been the case with the nerve. As regards the possibility of sensory nerves showing a different reaction to motor, Grützner long ago pointed out the fact that they were readily stimulated by potassium chloride and acids, while motor nerves were not. Every one knows that acids will stimulate some sensory end organs, presumably by means of the positive ions the acids contain. Knowing these facts, it was easy to infer that sensory nerves were electro-negative and were stimulated by salts having a predominant positive ion, while motor nerves were electro-positive and were stimulated by the anion. Were this true, we should have a positive variation in sensory nerves and a reverse electrotonic effect from that in motor.

* Loeb, *Pflügers Archiv f. die ges. Physiologie*, Bd. 95, 1902, p. 255.

I accordingly tried experiments on the sensory nerve trunks of frogs more than a year ago, but I found the response to sensory stimuli so uncertain as to make the results valueless. Further experiments are necessary before speaking definitely, but thus far I have been unable to obtain any conclusively different results in sensory from motor nerves. I mention this fact to show that the argument that positive ions stimulate sensory end organs is not incompatible with my own conclusions and the facts were well known to me.

1. *The anion stimulates motor nerves; the cathion reduces irritability.* Loeb contradicts this statement for muscle because barium chloride stimulates muscle. The stimulating action he refers to the cathion. Barium chloride of an M/10 or weaker solution will also stimulate motor nerves, and is in these strengths a better stimulus than an equivalent sodium chloride solution. My former statement including barium chloride among the non-stimulants was wrong, the mistake arising from a series of negative observations. Mr. O. H. Brown called my attention to this error. The stimulating action of barium chloride is, however, due to the anion and not to the barium, although barium nitrate and acetate will also stimulate. That it is the chlorine and not the barium which stimulates may be shown by stimulating the nerve or the muscle with non-polarizable mercury, calomel, barium chloride electrodes. If barium stimulates the contraction should begin at the positive electrode on the make of the current, as well as at the negative, for at the anode barium ions are passing into the nerve. It was found that the contraction always began at the cathode on the make as with sodium chloride. The experiment was also tried of soaking the nerve or muscle in barium chloride for many minutes previous to stimulation, so that barium chloride might be present in the muscle and nerve in large amounts. No change in the nature of the response could be observed. Similar experiments with electrodes of aluminum chloride, manganese chloride, magnesium chloride, zinc chloride and other metals gave the same results as sodium chloride, except that a greater depression may occur at the anode. These facts show that the stimulation is due to the anion and not to the cathion.* Further evidence will be given to support this conclusion. Barium chloride resembles sodium chloride in many of its reactions, so that there is little doubt that if the sodium salts stimulate by their anions the barium salts do also. I think it probable that barium chloride stimulates because the two charges on the chlorine overbalance the two charges on the barium. This physiological difference between barium and calcium and sodium and potassium is in line with their chemical behavior. Barium chloride solutions contain no hydrogen ions produced by electrolytic dissociation, while calcium and magnesium do; and potassium chloride, while not containing hydrogen ions itself, facilitates catalyses produced by such ions, while sodium has not this property. Why the two calcium charges are more efficient than the two barium charges is still obscure, but may be due to the charge being more firmly attached to the barium than to the calcium, or that the charge has a different motion in the two cases.

2. *The relative stimulating efficiency of the anions* is primarily, as already stated, proportional to the number of charges on the anions. Further observations on more nerves and other salts show that the monovalent anions are to the divalent and the

* I owe the suggestion of using electrodes in this way to Dr. Lingle, who has already employed it on heart muscle.

trivalent in their stimulating capacity approximately as 1:2+:3.5, and not as Hardy found in colloidal solutions proportional to a power of the valence. There are variations from this rule, some monovalent anions, *i. e.,* hydroxyl, being nearly as powerful as divalent. The formate, however, is not an exception to the rule in the nerve, whatever it may be in muscle. It is, however, somewhat stronger than the chloride. Such variations are in no way antagonistic to the general conclusion that it is the charge which stimulates, and attention was called to them in my original paper. They probably mean that the number of charges is not the sole factor, but possibly, as already suggested, it is rather the motion of the charge around or with the atom or the affinity of the charge for the atom.

3. The general rule that the inhibiting action of the cathion is proportional to its valence or its electrical charges holds true, but here even more than in the anions there are exceptions, monovalent ions sometimes being stronger than one half of a bivalent ion. These exceptions need further study and do not invalidate the general conclusions, for, so far as I have examined, the only bivalent cathion which is weaker than two monovalent anions is barium.

4. That barium chloride stimulates by means of the anion is shown also by the fact that its stimulating action may be neutralized by any of the agents used to neutralize the stimulating action of sodium chloride, *i. e.,* by the addition of small amounts of $CaCl_2$, KCl, LiCl, $NH_4Cl$ and probably other salts having predominant positive ions. More of these salts are required than are required to neutralize NaCl, which agrees exactly with the theory. These facts were predicted, and experiments confirmed the prediction even to the amounts of salts necessary to add. Furthermore, barium chloride, like sodium chloride or other sodium salts, places the end of the nerve in a condition of catelectrotonus, so that if the end of the nerve is cut off after immersion in any of these salts, the muscle goes into a tetanus and may remain in a tetanic contraction for many minutes, in some cases even half an hour. This tetanus corresponds closely to the tetanus observed on cutting the nerve between the electrodes with the anode near the muscle during the passage of the current, and is, I believe, due to the same cause. This similarity of action between sodium and barium salts shows them to act in the same way in the nerve, but the barium salts somewhat more strongly. The fact that barium chloride may be neutralized in its poisonous and stimulating action by calcium chloride is difficult to reconcile with the hypothesis that antitoxic action occurs between monovalent and polyvalent positive ions.

5. If sodium chloride stimulates by the anion, as electrical stimulation clearly indicates, it should be possible to neutralize its stimulating action by adding small amounts of any salt of which the positive ion preponderates, but not by any salt of which the negative ion preponderates. This is the case: The stimulating action of sodium chloride may be neutralized by small amounts of the chlorides of lithium, potassium, hydrogen, ammonium, aluminum, calcium, strontium, zinc, cobalt, manganese or magnesium. The amount of salt necessary to neutralize varied in different cases, more lithium being necessary than potassium. The salts were found to range themselves in this action in the same order of efficiency as previous experiment had shown them to act as depressors of irritability. The order was predicted from the theory and confirmed by experiment. The exact figures will be given in the full

paper. By this method we can arrive at the exact relative physiological efficiency of the different positive ions, and, so far as I have gone, it corresponds closely with the chemical or catalytic action of these ions.

The addition to sodium chloride of any salt of which the anion overbalances more than chlorine does over sodium should not neutralize the poisonous or stimulating action of sodium chloride, but should increase the latter. This is the case: The addition of barium salts, or of sodium sulphate, phosphate, citrate or ammonium citrate increases the stimulating action of sodium chloride.

6. If sodium chloride is poisonous because the chlorine predominates, we should be able to neutralize its poisonous action by predominant positive ion salts, but not by predominant negative ion salts. This is the case so far as observations go: The addition to sodium chloride of small amounts of calcium chloride, as found by Howell, or potassium or lithium, will greatly prolong the life of the nerve immersed in the solution. The toxic and antitoxic action, so far as the nerve is concerned, and I believe in other cases also, is thus shown to be due to a neutralization of a predominant ion by an ion of an opposite charge, and is not due to any antitoxic action between monovalent and divalent positive ions. The stimulating action of the sulphate or citrates can not be referred primarily in my opinion to their precipitation of calcium or rendering it inert. The stimulating action of these salts may be neutralized, for example, by potassium where there is no question of precipitation. The antagonistic action is thus shown to be due probably not to a combination between the toxin and antitoxin, but to the fact that each of these acts on the protoplasm, but in an opposite manner.

7. The theory that positive ions act like the anæsthetics and depress protoplasmic activity or inhibit has been confirmed by observations on the eggs of echinoderms. The anæsthetics liquefy these eggs; liquefaction is also caused by the electric current on the anode side. These results were obtained by Mr. O. H. Brown. Further analogies of action were observed by Dr. Spaulding and will be published shortly. Preliminary experiments on the nerve indicates that this resemblance extends possibly to protoplasmic respiration, salts of a predominant positive ion checking respiration while those of predominant negative ion increase respiration, at least temporarily. My experiments are, however, still too few to enable positive statements to be made.

8. The current of rest of motor nerves shows marked fluctuations if the tip of the nerve is dipped into acids, alkalies or salt solutions. The acids quickly depress the current, alkaline salts increase it. The current may thus be many times abolished by acids and reappear on dipping in sodium hydrate. These results are being carried further. They indicate the general truth of the conclusions of the opposite physiological action of anions and cathions.

9. The results recorded of the antagonistic physiological action of the anions and cathions hold also for the central nervous system and for the kidneys. This work has been done by Dr. S. A. Matthews and Mr. O. H. Brown and others in this laboratory and will be shortly published. They show that the motor nerve is not unique, but that its reaction corresponds to those of many other tissues.

I believe that the exceptions observed by Loeb in muscle may be explained in part by the fact that when a muscle is put into a salt solution it is impossible to state

whether the contractions arise from the nerves, nerve ends, the muscle substance or a disturbance of the electrical equilibrium within the muscle mass. It must not be forgotten also that the relaxation of the muscle is possibly an active process, and, as experiments indicate on cilia, the relaxation may be stimulated by the positive ions, the contraction by the negative, somewhat as Howell suggested for potassium and calcium in the case of muscle. Lingle has already worked in this direction and will no doubt be able to clear up some of the discrepancies.

10. I believe the results so far obtained support strongly the truth of the hypothesis of the antagonistic action of the anions and cathions on protoplasm. They support Loeb's original suggestion of the importance of valence and of my conclusion that in motor nerves and some other tissues the anion stimulates, while the cathion inhibits. They also support the explanation of chemical and electrical stimulation and electrotonus given in my former paper.

11. The results obtained indicate also the truth of the general law, *i. e., the physiological action of any salt is equal to the algebraic sum of the actions of its ions.*

A. P. MATHEWS.

CHICAGO,
March 3, 1903.

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### *STREMMATOGRAPH TESTS. PRINCIPLES AND FACTS RELATING TO THE DISTRIBUTION OF THE STRAINS IN THE BASE OF RAILS UNDER MOVING TRAINS.*

BEFORE it was possible to make any tests of precision showing the distribution of the stresses in rails under moving locomotives, it was necessary to improve the tracks, and introduce stiffer rails than were in use prior to 1884. The 4½-inch 65-pound rails, with their splice bars, were too weak to distribute the loads of the locomotives and cars in an efficient manner. While the distribution theoretically follows the same general law in the lighter rails, yet the efficiency is so much less that it is impossible to obtain comparative tests in practice to confirm the theory of the distribution of stresses under locomotives.

On the 4½-inch rails, the heaviest axle loads on passenger locomotives prior to 1889 were about 27,500 pounds. When many miles of the stiffer 5-inch 80-pound rails were in the track, the axle loads were increased to 40,000 pounds per pair of driving wheels.

The stiffer rails permitted better joints, capable of holding up the ends of the rails, which continued the functional action of a rail as a continuous girder to adjacent rails.

After the stiffer rails have been well surfaced in the track, the portion under the driving wheels becomes practically a restrained beam with numerous supports, the front end being held down by the forward truck wheels, and the other portion of the rail by the tender wheels.

The stiffer rails have been laid upon the same road-beds, without increase of width, to distribute laterally the heavier wheel loads to more breadth of road-bed.

The track for steam railroads is by construction flexible, but notwithstanding the high standards of smoothness which have been secured by reducing the looseness of the superstructure and its flexibility to small limits by stiffer rails, it is not a limited flexible structure like a bridge, in which the strains in the members may be analyzed and calculated.

The problem—or series of problems—in reference to the strains in rails and their distribution under moving locomotives and cars, is so complicated by the looseness of the superstructure and the imperfect elasticity of the road-bed, that it has not yielded to mathematical analysis, as for

bridge members. While safety is the paramount question in either the bridge or rails, the conditions of service are so dissimilar that the same rules as to factors of safety do not apply. The bridge must support itself and the imposed load, while the rail is supported and distributes infrequent driving-wheel loads of large intensity of strain for a small fraction of a second. These can be repeated a few times daily and the rails not break, for years of service. In a bridge a strain lasts for several seconds, and must be limited to higher factors of safety.

The rails rest upon the cross-ties, and are spiked with ordinary hook spikes, which form a secure but not a rigid fastening. There is a slight looseness between the rail and the spike, between the rail and the cross-ties, and the latter in the ballast, which becomes decided under the rapid movements of the locomotives, increasing the strains in the rails.

The stremmatograph was designed to record autographically the strains in the base of the rails under moving trains. A series of stremmatograph tests have been made under moving trains in service, principally upon the 80- and 100-pound rails, having three-tie points, of the New York Central & Hudson River Railroad.

At first it was considered that the important problem would be to ascertain the maximum strains to determine the factors of safety in the rails. Numbers of such tests have been made, and it was found that under fast trains, at fifty miles per hour, it was not uncommon to record unit fiber strains in the base of the rails as high as 40,000 or even 45,000 pounds. The elastic limits in the steel of the rails under test run from 55,000 to 60,000 pounds, almost as high as the ultimate strength of bridge and structural steel.

In comparing the results of a number of tests it was noticed that the stresses under similar wheels were not alike, but when the total stresses for the entire locomotive were considered, close approximations were obtained, from two or more locomotives of the same class, when running at the same speed and doing the same work. Then a series of tests was undertaken of the highest precision, to trace the distribution of the stresses under the locomotives. It was found after a number of tests were reduced, that it was possible with two locomotives of the same weight and class, doing like work, the wheels being in perfect condition as to smoothness, to obtain results which would compare within one half of one per cent. when they were taken on the same rail, without any other locomotive passing over the rail in the meantime.

Numbers of stremmatograph tests have been tabulated and studied, from which some principles and facts have been deduced. These principles illustrate particularly the early American theory and practice of distributed wheel loads, and were applied in the inception of our railroads, and are still the basis of our unexcelled practice. They were understood qualitatively, and the railroads constructed in accordance therewith, but were not pointed out specifically, owing to the fact of the inability of making quantitative determinations of the forces transmitted to the rail and road-bed by the moving locomotives and cars. The state of the art rather than the science was the guide for practice.

Seven principles and three facts have been traced, which are true generally as applied to railroads, although high efficiency can not be obtained on tracks of light rails. This does not affect the principles, only the degree of efficiency attained.

One of the earliest efforts of the American engineers, after locomotion had been secured, was to adapt the construction of the wheel base of the locomotive and cars to the track, so that in their movements they would produce as little destructive action as possible. That became the guiding feature in the construction of the early railroads.

The track being a flexible construction, an effort was made to utilize a portion of the wheel base to stiffen a portion of the track for the heavier wheel loads.

Each type of locomotive would make a distinct general depression in the superstructure, as well as specific deflections under the individual wheel loads.

Mr. John B. Jervis, the chief engineer of the Mohawk & Hudson Railroad, in 1831, after the trials with the English locomotives, and also with the 'DeWitt Clinton,' observed that the motion, particularly of the English locomotives, of two pairs of wheels for the wheel base, was very unfavorable not only to the track, but severe for the engineer and fireman. Mr. Jervis was formerly the chief engineer of the Delaware & Hudson Canal Co., and had imported some English engines for use upon that road, when it was to be opened in 1829. The first locomotive made by R. Stephenson & Co., the 'America,' was landed in New York in May, but for some unexplained reason was never sent to the road. Later the 'Stourbridge Lion' arrived, which was constructed by Foster & Rastrick, of Stourbridge, England. This was sent to Honesdale, Pa., and a trial made with it on August 8, 1829. Mr. Horatio Allen, who had formerly been associated with Mr. John B. Jervis, and supervised its construction in England, acted as the engineer. No one else was upon the locomotive. The engine was started and run across the trestlework over the Laxawaxen Creek, and returned without accident. This completed its running, but not its service to American railroads. The engine was too heavy for the track, the weights upon the axles being greater than had been anticipated or prescribed by Mr. Jervis, and the structure was not capable of sustaining the locomotive.

Messrs. Jervis and Allen, after noticing the injury to the track by the 'Stourbridge Lion,' eventually devised entirely different mechanisms for application of the principle of subdividing and distributing the total load of the locomotive to the track. Mr. Horatio Allen designed an eight-wheel engine for the purpose. Each pair of driving wheels was driven by a separate cylinder, but they were not connected so as to keep the cranks at right angles to each other. Mr. Jervis designed, in place of one pair of driving wheels, a flexible four-wheel truck to support the front end of the engine, which served to subdivide the total load of the engine, and connected a pair of driving wheels to the main frame which supported the boiler and machinery of the engine.

While Mr. Allen and Mr. Jervis both had the idea of distributing the total load of the locomotive to a longer portion of the track, each used a different mechanism for applying the principle. The mechanical application of Jervis still survives and is in general use on most of the locomotives in the railroad world.

After three score and ten years of service and experience, the mechanical application of Jervis is the best. Mr. Allen's system was confined to three or four locomotives, and was succeeded on the same railroad by locomotives with the Jervis truck, the first one being named the 'E. L. Miller,' constructed by Mr. Mathias Baldwin, the founder of the Baldwin Locomotive Works.

Mr. Jervis's mechanical application made the state of the art so complete that his theory has been well-nigh forgotten.

The stremmatograph confirms the theory that on tracks of stiff rails and joints, locomotives when drawing their trains distribute their total load and effects of the expended tractive effort in accordance with a principle of mechanics. In the evolution of American locomotives this principle has received its greatest application, not only in more wheels in the wheel base of the engine, but in that of the tender.

The decided advantage of being able to distribute the total load of the locomotive through a number of wheel contacts, enables a heavy load to be carried without unwarranted injury to the track, by making the forward wheels check deflections under the following driving wheels. The drawbar-pull also becomes of assistance in the distribution of the loads on the driving wheels and effects of the expended tractive effort. In this way the combined stability between the locomotive and the superstructure of the permanent way is increased.

The rail is the most important member of the conservative system either of the superstructure of the track or of the permanent way. The bending of the rails is produced directly by the moving wheel loads, and the tension under one wheel contact can not take place without producing compression at some other point. Therefore, bending in either direction is resisted by the metal, which helps distribute the load to a longer portion of the track than is possible on lighter rails.

The combined stability, efficiency and capacity between the locomotive, rolling stock and the permanent way increase in a faster ratio than the direct stiffness between two sections of rails. This is shown by the great increase in the weight of the locomotives and cars in the last few years, running over the same road-beds which were formerly laid with light rails.

The stresses of the specific deflections of the different wheels of the locomotive running over a flexible track are of necessity quite irregular. The irregular application of steam also makes an irregular distribution of the stresses per revolution.

As the smoothness of the track has increased, the realized coefficient of adhesion of the system of the driving-wheel base of the locomotives has also increased.

P. H. Dudley.

## SCIENTIFIC BOOKS.

*Analytical Chemistry.* By F. P. Treadwell. Translated from the second German edition by William T. Hall. Vol. I., 'Qualitative Analysis.' 8vo. Pp. xi + 466. New York, John Wiley & Sons. 1903.

There are so many books on qualitative analysis, and so many of them have little reason for existence, that it is a matter of satisfaction to examine one, like the work under consideration, which possesses many features of novelty and excellence.

The book begins with an introduction explaining general principles, including the law of mass action and the ion theory of Arrhenius. While the latter theory is apparently advocated, its influence is shown but little in the book as a whole. For instance, in the first part of the introduction it is stated that a precipitation always takes place when an insoluble substance is formed by means of a 'chemical decomposition,' and, although the part of the book which treats of acid radicals is headed 'Reactions of the Metalloids (Anions),' the substances dealt with are called 'acids.' This neglect of the modern theory will be approved by some, but it will be objected to by many.

The book seems to be particularly good in its clear and full descriptions of qualitative tests. Many new and improved methods are introduced, and the methods adopted are generally very satisfactory. However, the re-

tention of the calcium sulphate method for testing for barium and strontium, which has been abandoned by Fresenius and others, is open to criticism, and the failure to mention de Koninck's excellent potassium cobaltic nitrite test for potassium seems unfortunate in view of the increasing cost of platinum, and of the fact that the test is much more delicate than the one with hydrochloroplatinic acid. Those who have used Gooch's separations of lithium chloride from sodium and potassium chlorides, and of calcium nitrate from strontium nitrate, by means of amyl alcohol, will regret that they receive no mention here.

A striking and valuable feature of the book is the elaborate treatment of the equations of the reactions. In these equations the formulas are frequently rather elaborately developed according to the theory of valency, a practice which at times seems to involve an unnecessary waste of space, on account of the uncertainty of the positions of the atoms in the inorganic compounds.

The part on the acids is unusually full and extensive, including a number of acids that are not usually considered in the text-books. There is a supplement, also, which deals with the rarer metals.

Analytical tables, to which some teachers object, are freely used, but it is stated that in the author's experience these have given the best results.

The translation appears to have been very well done, but a number of errors, particularly in the equations, indicate some lack of care in proof-reading. H. L. W.

*The Movements and Reactions of Fresh-water Planarians: A Study in Animal Behaviour.* By RAYMOND PEARL, Ph.D. *The Quarterly Journal of Microscopical Science.* Vol. 46, 1903, pp. 509–714.

This paper from the zoological laboratory of the University of Michigan gives a detailed account of a very thorough and careful study of the behavior of planarians. Dr. Pearl states in his introduction that it is his purpose to give such a complete account of his observations that no desired information concerning the work shall be lacking. In America, especially among physiologists, the tendency is to limit papers to the bare statement of results; details of method and observation are omitted. This Dr. Pearl considers an unfortunate tendency; he, therefore, presents a minutely descriptive paper. But even two hundred pages on planarian behavior are not tiresome in this case, for the paper is written with a noteworthy clearness, accuracy and precision of statement. Everywhere it inspires confidence in the reliability of the observations and experiments. The author's painstaking care, resourcefulness and enthusiasm for research are unmistakable. Although Dr. Pearl is evidently responsible for the whole of this study, he gives generous thanks to Professor Herbert S. Jennings for suggestions, criticisms and general helpfulness. Professor Jennings is really the pioneer in the analytic study of animal behavior in this country, and his excellent work on the reactions of unicellular organisms is inspiring many to research along similar lines.

In the paper at hand we find the following chapters: (1) 'A Résumé of the Literature Bearing on the Subject,' (2) 'A Discussion of the Habits and Natural History of Planarians,' (3) 'A Description of the Normal Activities of the Animals,' and (4) 'A Consideration of Their Reactions to Stimuli.' In this chapter the author deals with: (*a*) reactions to mechanical stimuli, (*b*) reactions to food and other chemical stimuli, (*c*) thigmotactic and righting reactions, (*d*) reactions to an electric current, (*e*) reactions to desiccation, and (*f*) reactions to currents of water (rheotaxis).

Throughout the investigation Dr. Pearl's aim has been to analyze all the reactions into their reflex components and to describe the mechanism of each reaction. Briefly stated, the most important results of the investigation are as follows: (1) The normal locomotor movements of planarians are two: *gliding,* by the beating of the cilia on the ventral surface, and *crawling,* due to longitudinal waves of muscular contraction. (2) The animals fa-

tigue quickly and periods of rest alternate with periods of activity, as in more highly organized animals. (3) There is surprising sensitiveness to mechanical stimuli; it is found that even touching the surface of the water near the animal with a needle point causes a visible reaction. (4) Two types of reaction are given to stimuli: the *positive*, which is called forth by weak unilateral stimulation of the head region, serves to take the animal toward the stimulus (important for the obtaining of food); the *negative*, which results from strong stimulation of one side of the anterior region of the body, evidently serves to take the animal away from harmful stimuli. (5) Dr. Pearl calls attention to the fact that *intensity* and *not quality* of stimulation determines which kind of reaction shall be given. In case of all chemicals whose effects were studied it was found that to all solutions above a certain strength the negative reaction was given; to those below, the positive. (6) The reactions to chemicals are practically identical with those to mechanical stimuli. (7) There is no evidence that planarians orient themselves with reference to the lines of diffusing ions of a chemical; instead the reactions are merely repetitions of the positive and negative reactions mentioned. A planarian in the neighborhood of a piece of meat does not turn directly toward the food substance, thus bringing its long axis parallel to the diffusion lines of the substance, but glides along without any evident uniformity of relation to the lines. If it chances to be headed toward the meat when it enters the region of diffusion it obtains the food directly, if not, it continues its forward movement until it is stimulated to give the positive reaction. Thus, the forward gliding followed by the positive reaction may be repeated several times before the organism happens to come in contact with the food substance. (8) The ventral surface of planarians is strongly positively thigmotactic, whereas the dorsal surface is negatively thigmotactic; hence, when turned over so that the dorsal surface is in contact with a solid, the animal immediately rights itself by an extension of the edge of the body which is in contact with the solid. The analysis of the righting reaction given by the author is admirable. (9) The reaction to a constant electric current consists of a turning of the head toward the kathode.

As the author says: "All the normal reactions to stimuli are of the nature of reflexes, more or less complex. What the animal will do after a given stimulus, or in a given situation, can be predicted with reasonable certainty. There is, however, some variation in the behaviour, depending on the physiological or tonic condition of the individual at the time of stimulation. Thus a stimulus sufficiently weak to induce the positive reaction in one specimen may cause the negative reaction in another; or at different times the same individual may show different reactions—either the positive or negative—to the same stimulus" (p. 703).

Concerning the psychological position of planaria Dr. Pearl makes some very sane remarks. His study enables him to say that the reactions of this flat-worm are much more complicated than those of the unicellular organisms as described by Professor Jennings. There is, moreover, a certain amount of variability and adjustment to the demands of a situation. The chief function of the planarian brain is the 'preservation of the tonus of the organism,' while the main function of the nervous system as a whole is 'the rapid conduction of impulses.' Dr. Pearl says he does not think we can say whether the worms possess consciousness or not. And he adds: "Any 'objective criterion' of consciousness does not exist." He might well have said that *no such criterion is possible*.

One might with some cause criticise the paper on the ground of undesirable prolixity. The author has everywhere given full descriptions of his methods and results, and in addition he frequently gives diagrams to illustrate the reactions. Sometimes these diagrams are quite unnecessary in view of the simplicity of the reaction and the clearness of the verbal description. There is also unnecessary repetition throughout the paper. The author has gone to the opposite extreme, in his effort to avoid the omission of significant details.

For the work itself we have only praise. It is an important contribution to comparative physiology. ROBERT YERKES.

HARVARD UNIVERSITY.

*A Course in Invertebrate Zoology.* A Guide to the Dissection and Comparative Study of Invertebrate Animals. By HENRY SHERRING PRATT, Professor of Biology at Haverford College and Instructor in Comparative Anatomy at the Marine Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, L. I. Boston, Ginn & Co. 1902.

Dr. Pratt's 'Invertebrate Zoology' is strictly a laboratory book, intended to give the student all the information and directions which are needed for the intelligent laboratory study of animals, and nothing more. In this the author has as a rule succeeded admirably. His attempt is to give such practical directions that the student can go on with his work profitably without having an instructor at his elbow. In carrying out this attempt he has not hesitated to give directly such information as is necessary to enable the student to do the work intelligently, and has not attempted to disguise his information under the form of questions—a ruse which has proved so disfiguring to many of the recent laboratory manuals. The absence of pedagogical fads is in fact noticeable and refreshing. The information given is chosen judiciously to accomplish the purpose for which it is intended. There are no figures in the book, as the laboratory work takes largely the form of drawing the careful dissections made, and the author has doubtless experienced the strong tendency of students to imitate the figures of the text. Commendably explicit directions are given for making these drawings.

The plan adopted is to study each one of the larger groups of invertebrates as a whole, several of its representatives being dissected in such a way as to bring out relationships. The first group taken up is the Arthropoda, including study of a wasp, a beetle, a grasshopper, a caterpillar, a centiped, the crayfish or lobster, a crab, a sow-bug, an amphipod, *Caprella,* larval decapods, a copepod, *Daphnia,* and a nauplius larva. Somewhat less extensive studies are undertaken of the Annelida, the flatworms, Bryozoa, Mollusca, Tunicata, Echinodermata, Cnidaria, sponges and Protozoa. While the directions are comparative, the author has tried to make those for each organism complete, so that every teacher may take up the forms in such order as he chooses. Doubtless most teachers would desire to modify the directions in some points to suit their own methods of work; a lack of precision to be noticed in some cases in the directions for the dissection of some of the more difficult systems of organs may thus be remedied. The main body of the book is followed by an outline of animal classification and a glossary of the terms used in the directions.

The book will certainly be found very useful both to teachers of invertebrate zoology and to those attempting without the aid of a teacher to obtain some practical knowledge of the anatomy of invertebrates. While the well prepared teacher can usually work best with laboratory directions which he has himself prepared, even this class will find the book suggestive and helpful.

H. S. JENNINGS.

ANN ARBOR, MICH.,
April 16, 1903.

## SOCIETIES AND ACADEMIES.

### GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 141st meeting of the society, held in the assembly hall of the Cosmos Club, Wednesday evening, March 25, 1903, three interesting papers were presented.

Under the title 'Statics of a Tidal Glacier,' Mr. G. K. Gilbert said in part:

"An iceberg floats in sea water with about seven eighths of its mass submerged. A glacier entering an arm of the sea with a depth less than seven eighths the thickness of the ice continues to rest on the bottom. In the discussion of the origin of fiords it is generally assumed that such a glacier is partly sustained by the sea water, and that the rock bed is to the same extent relieved of ice pres-

sure. A little consideration shows that the water pressure against the vertical front of the glacier has no sustaining power. The ice can be hydrostatically supported only through pressure communicated to its under surface. If there is water contact throughout the base of the glacier, then no share of the weight of the ice is directly borne by the rock bed, but the whole weight comes upon the water; and since earth heat keeps the base of a glacier at the temperature of melting, there must always be a film of water beneath it. This film is not expelled by the pressure to which it is subjected, but is reduced to capillary thinness. It does not obey the hydrostatic law, but the laws of surface tension. The molecular forces associated with its two contact surfaces are dominant, and give it quasi-solid properties. The film sustains the whole weight of the superincumbent ice, and communicates its pressure to the rock bed, and this without reference to the absence or presence of sea water. The pressure conditions at the base of the tidal glacier are practically the same in its tidal portion and its land portion, and it has the same power to erode its bed below sea level as above."

It follows, as a corollary, that the existence of a fiord is not *prima facie* evidence that the land had a different relation to sea level at the time of its excavation.

Mr. Whitman Cross, 'Observations on Hawaiian Geology.'

Mr. Cross gave a brief sketch of the geology of the Hawaiian Islands, and described the small but interesting eruptions of Kilauea which have occurred within the past year. Special attention was called to the long series of eruptions of basaltic lavas which has continued from some unknown date in the Tertiary to the present time. That no other lavas should have alternated with basalt and that no apparent progressive change in the characters of the lavas has taken place, contrasts markedly with the history of most volcanic centers. The discovery of trachytic rocks at one point on the island of Hawaii, announced by Mr. Cross, is but the exception proving the rule. In all the older, much dissected islands, no such unusual lavas have been found.

Mr. Cross spoke of the exceptional opportunities for the study of physiographic processes, since the various islands exhibit all stages in the sculpturing and degradation of volcanic mountains from the unmodified dome of Mauna Loa to the islet, hardly more than a reef, the remnant of a former basaltic volcano.

The recent eruptive activity of Kilauea, beginning in June, 1902, was confined to the pit crater of Halemaumau. This pit is 1,200 to 1,500 feet in diameter, and was about 1,000 feet deep before the lava appeared in its bottom, last June. The sum total of many small gushes of lava up to the end of 1902 was enough to fill up the pit to a distance between 700 and 800 feet below the crater rim.

Mr. Bailey Willis, 'Post-Tertiary Deformation of the Cascade Range.'

Mr. Willis discussed the form of the mountain block which had been elevated (or left in relief through general subsidence) in the development of the Cascade Range. The conception of form was arrived at through study of a warped peneplain of post-Miocene age, which over a wide area is now elevated to altitudes of 3,000 to 8,500 feet. The criteria applied to test the deductions as to form are of a physiographic nature; streams are found to be in part antecedent, in part consequent, and in part adjusted through piracy. In valley profiles there are recognized monadnocks, the peneplain, the post-peneplain mature topography, and the still later canyon topography, the last antedating the latest glacial epoch. Lake Chelan, the central feature of the district discussed, is found to have a complex history, having developed through stream robbing as an extensive canyon, and having been excavated to a depth of a thousand feet below its rock rim by glacial erosion, under peculiar conditions of constriction and pressure of the ice.

The subject discussed will be illustrated in a forthcoming professional paper of the Geological Survey. W. C. Mendenhall,
*Secretary.*

## THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE third meeting of the Society for Experimental Biology and Medicine was held on the evening of April 15, in Professor Graham Lusk's laboratory at the University and Bellevue Hospital Medical College, New York City. Dr. S. J. Meltzer presided.

In harmony with the aims of the society the evening was devoted mainly to reports of original work done by the members, with demonstrations of methods and results. The program was as follows: *

### I. REPORTS OF ORIGINAL WORK, WITH DEMONSTRATIONS.

*Changes in the Blood-volume of the Vein of the Submaxillary Gland on Stimulation of the Chorda Tympani and Sympathetic Nerves:* R. Burton-Opitz.

Dr. Burton-Opitz explained the mechanism of a recording stromuhr by means of which he made quantitative determinations of the blood flow in the vein conveying the blood from the submaxillary gland. The blood-volume was measured previous to, as well as during, the stimulation of the secretory nerves. The curves which were exhibited showed very striking changes in the blood-flow, namely, an increase on stimulation of the chorda and a decrease when the current was applied to the sympathetic fibers. In the former case the volume of the blood flow (cubic centimeters per second) was from about two to nearly six times as great as normal, and in the latter case it was from about one half to one fifth the normal volume. By using a strong stimulus a complete cessation of flow can be produced.

* The secretary has received an abstract of each report from the member making it, and in editing these abstracts has made only occasional verbal and minor alterations in them, such as abbreviations and the like. The abstracts here given are in fact, therefore, the contributions of the several members themselves, and should be so credited. This statement applies to the former report also (SCIENCE, XVII., p. 468), and will be true of those in the future.

*Does a Backward Flow ever occur in the Veins?:* R. Burton-Opitz.

The results of this investigation may be summarized as follows: A backward swaying of the column of blood in the central veins is a constant, normal phenomenon. It is produced by two factors: first, by the contraction of the right side of the heart, and secondly, by high intra-thoracic pressure (forced expiration). If the distal conditions in the venous system are favorable, this backward movement can also be obtained in the peripheral veins (femoral vein). The same instrument was used in this investigation as in the former.

*A New Method of Studying Metabolism:* Gary N. Calkins.

Dr. Calkins described experiments now in progress upon metabolism in unicellular animal organisms. These forms, reproducing by simple division, offer the same protoplasm for study, generation after generation, and, with each division, the daughter organisms, by reason of the functions of regulation and regeneration, perfect themselves in the race-type, while digestion, assimilation, waste, repair and growth are handed down unchanged from cell to cell. The problem is to ascertain whether these various functions will continue their activities indefinitely or whether protoplasmic old age will supervene to put an end to the race. In nature such an end is prevented by sexual union, whereby the conjugating organisms are rejuvenated.

In the experiments this function was prevented by isolation. The general metabolic functions *wore out* four consecutive times at intervals of six months, and each time, except the last, the race was saved only by a change in diet or by chemical stimuli. The phenomena were analogous to those in the artificial fertilization experiments of Loeb and others, with this difference, that, if comparable with artificial parthenogenesis, the process was repeated with the same protoplasm three consecutive times. In the fourth period of degeneration the stimuli previously tried were no longer effective and the race died out, 742 generations old. Structural changes were different in the different periods of depression.

The degenerate animals, in the periods which were successfully overcome, had curiously altered nuclei and endoplasm. In the last period of depression which was not overcome, the nucleus and endoplasm were normal, while abnormal parts were found in the micronucleus and the cortical plasm.

The conclusions which this part of the work seems to justify are: (1) That 'old age,' so-called, of the cell, may be due either to the wearing out of functions, or to the degeneration of structural parts. The former is capable of artificial rejuvenescence, the latter apparently not. (2) The ordinary functions of metabolism, such as digestion, assimilation, excretion, growth, etc., are dependent upon certain definite portions of the cell (macronucleus and endoplasm), while the dividing energy is a function of the micronucleus and of the cortical plasm. (3) After conjugation, the organisms start with high potentials of metabolic energy which gradually wear out, but which can be restored artificially. So, too, the dividing energy starts with a high initial potential energy, but which can not be restored after exhaustion.

In the light of these experiments it would be pertinent and instructive to ascertain whether artificial parthenogenesis, in sea-urchins for example, could be repeated more than once on the same continuous protoplasm. On *a priori* grounds a successful result would be extremely doubtful.

*On the Origin of Cholesterin in Gall-stones:* C. A. Herter.

Dr. Herter said that experiments made in his laboratory by Dr. Wakeman give strong support to the view that inflammatory conditions of the walls of the gall-bladder may lead to an increase in the cholesterin of the bile. Dr. Wakeman injected strong solutions of bichloride of mercury into the gall-bladders of dogs previously starved for three days. After periods of from two to five days the animals were killed. As a rule, the gall-bladder walls were much thickened and the epithelium was proliferated and desquamated. The solids of the bile were diminished in percentage. The cholesterin content was much increased. The contents of the gall-bladder in these experiments were sterile. These facts are of great interest in relation to the etiology of gall-stones.

*On Nucleic Acid:* P. A. Levene.

According to Osborne, nucleic acid derived from the plant cell differs from that of the animal cell with variation in the characters of the pyrimidin base present in its molecule. Dr. Levene has devised a new method of separating the pyrimidin bases, in which he avoids the precipitation with silver. With this method he has obtained from the animal nucleic acid (derived from the spleen and pancreas), besides thymin and cytosin, also uracil. The radicle of the latter substance had been supposed to occur only in the plant nucleic acid. Kossel and Stendel have made the same observation in regard to the nucleic acids derived from the thymus gland and from fish sperm.

*Respiration Experiments in Phlorhizin Diabetes:* Graham Lusk (with A. R. Mandel).

An experiment on a diabetic dog showed that whether fasting, or fed on meat alone, or on meat and fat, no more fat was burned than in the same dog when he was normal and fasting.

*A Modified Eck Fistula, with a Note on Adrenalin Glycæmia:* A. N. Richards.

A method devised by Vosburgh and Richards for establishing communication between the portal vein and the inferior vena cava of the dog was described and demonstrated. In this method two cannulas are employed. They are constructed on the same principle as the one used by Vosburgh and Richards in collecting blood from the hepatic and portal veins without interfering with the normal circulation in those vessels (*Amer. Journ. Physiol.*, 1903, IX., p. 43). After suitable incision through the abdominal wall a cannula of that type, 1 cm. long, was inserted into the portal vein about 2 cm. below the entrance of the pancreatico-duodenalis. A second cannula of similar design was introduced into the vena cava at a corresponding point. By connecting the cannulas with a rubber tube, communication was established between the two vessels. On ligating the hepatic arteries and the portal vein at the

hilum of the liver, circulation through the liver ceased and the gland was extirpated.

By the successful use of this method Vosburgh and Richards have found that the application of adrenalin to the surface of the pancreas brings about a slight rise in the sugar content of the blood even after extirpation of the liver. Their experiments thus far have covered periods of from two to three hours, no systematic attempts having yet been made to get the animals to survive the operation.

II. REVIEW.

*Aims and Achievements in Recent Experimental Cytology:* Gary N. Calkins.

A review of Loeb's, Wilson's and Boveri's experimental researches.

WILLIAM J. GIES,
*Secretary.*

### NEW YORK ACADEMY OF SCIENCES.

#### SECTION OF BIOLOGY.

THE fourth meeting of the year was held at the American Museum of Natural History on April 13, Professor Bashford Dean presiding. Papers were read by Dr. A. G. Mayer on 'The Instincts of Lepidoptera' and Professor H. E. Crampton on 'Variation and Reproductive Selection in Saturnid Moths.' Abstracts of these papers follow.

The paper presented by Dr. Mayer was a mere preliminary account of certain observations made by the writer. It is planned that the research will be continued and finally published conjointly with Miss Caroline G. Soule. Certain lepidopterous larvæ, such as *Danais plexippus,* are negatively geotactic and positively phototactic toward the ultra-violet rays. The combination of these reactions in nature maintains the larva at or near the top of its food plant, where, incidentally, it finds the youngest and best leaves, and tends to prevent its crawling down and away from the plant, thus incurring risk of starvation. Other larvæ, such as *Pyrrharctia isabella,* are indifferent either to the attraction of gravitation or to ordinary variation in conditions of light. Others react differently at different stages of development. Larvæ which will devour only certain definite species of leaves may be induced to eat sparingly of any other sort, provided the instinct to eat be first set into operation by the presence of the proper food plant. Under such conditions about the same number of bites are taken upon each presentation of the uneatable food to the larva. This phenomenon may be called 'momentum of the reaction,' and inclines one to conclude that the eating reaction is probably an unconscious reflex. Another series of experiments appeared to show that larvæ are unable to learn to follow a definite path to their food, and that the associative memory of lepidopterous larvæ does not endure for as long a time as ninety seconds. Certain larvæ when about to pupate display a well-marked geotropism.

The mating instinct is called into play by the perception of the characteristic odor of the female, and is merely a phenomenon of chemotaxis uncomplicated by æsthetic appreciation or sexual selection on the part of the female.

Professor Crampton described briefly the principal results of a statistical study of the correlation between structural characteristics and reproductive ability or disability in *Samia cecropia.* It was shown that the pupæ of those individuals, male and female, which mated were different from those which failed to mate, although all were placed under the same conditions as far as possible. True reproductive selection was evident, and related to typical conditions as well as to variabilities. A brief discussion was given of the real basis for the selective process and of the relation between reproductive selection manifested after emergence to that selection which occurred during pupal existence.

M. A. BIGELOW,
*Secretary.*

#### SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

AT the meeting of the section on April 6, P. H. Dudley, C.E., Ph.D., of the New York Central and Hudson River Railroad, read a paper full of interest to those familiar with American railroad methods, on 'Stremmato-

graph Tests: Principles and Facts Relating to the Distribution of the Strains in the Base of Rails under Moving Trains.' This paper is published above.

S. A. Mitchell,
*Secretary.*

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

*March 27.*—Professor Grabau reviewed a paper by F. Noetling on 'Beiträge zur morphologie der Pelecypoden' (*Neues Jahrbuch*, 1902). Mr. C. W. Dickson reviewed the Quebec Group, especially in reference to its history and correlation.

*April 3.*—Professor Kemp reviewed several late papers from the *Transactions of the American Institute of Mining Engineers.*

*April 17.*—Professor Kemp exhibited and made a few remarks on the late folios of the U. S. Geological Survey. He also gave a short summary of 'The Two Islands,' an interesting book by Professor Thomas Condon, professor in geology in the University of Oregon. Professor Condon discussed in a semi-popular manner the geological history of these Archean islands, the one in the southeast and the other in the northwest part of Oregon. Dr. G. I. Finlay reviewed a paper by W. M. Davis on the 'River Terraces in New England' (*Bull. of Mus. of Comp. Zool.*, Vol. 38). Mr. C. W. Dickson reviewed several late papers from the American Institute of Mining Engineers. H. W. Shimer.

AMERICAN CHEMICAL SOCIETY.

NORTHEASTERN SECTION.

The forty-fourth regular meeting of the section was held at the rooms of the Technology Club, Boston, Friday, April 24, at 8 P.M. President A. H. Gill in the chair. Seventy-five members were present.

Mr. George W. Priest addressed the section on 'The Manufacture of Chrome Leather,' describing the usual method of preparing the raw hide for tanning, and the two methods used for chrome tanning, known as the one-bath and two-bath processes. The lecturer also described the new process for making patent leather from chrome-tanned skins, and exhibited specimens of leather tanned in various ways. The address was followed by a general discussion of the subject by members interested in the tanning industry.

Arthur M. Comey,
*Secretary.*

PSYCHOLOGICAL CLUB OF CORNELL UNIVERSITY.

The following papers have been read during the session of 1903:

Mr. B. L. Andrews: 'Tests of Audition: Clinical, Anthropometrical, Psychophysical.'

Dr. J. W. Baird: 'The Influence of Convergence and Accommodation upon the Perception of the Third Dimension.'

Professor I. M. Bentley: 'Clearness as an Attribute of Sensation'; 'Experimental Æsthetics.'

Dr. L. P. Boggs: 'Mental Elements and Mental Units.'

Dr. M. E. Schallenberger: 'Mind in the First Week of Infancy.'

Mr. H. C. Stevens: 'The Physiological Factors in the Normal Plethysmogram.'

Professor Titchener: 'The Method of Minimal Changes'; 'The Law of Error'; 'The Method of Average Error'; 'The Method of Right and Wrong Cases.'

## *DISCUSSION AND CORRESPONDENCE.*

### WALBAUM AND BINOMIALISM.

Mr. Henry W. Fowler, in Science for April 10, 1903 (p. 595), has expressed the opinion that 'Walbaum is non-binomial.' This assertion involves the names of many of our most common fishes and would necessitate numerous changes in nomenclature if true. Therefore, a restatement of facts in question appears to be called for. In fact, Walbaum is as binomial as Linnæus, if not more so.

Linnæus himself did not regard what is now called binomial nomenclature of much importance; indeed, he considered it to be simply a device for temporary purposes or for the facilitation of tabulation. What he did take pride in and credit for was the use of the specific name ('nomen specificum'), but this so-called name was not binomial, but of the nature of a diagnosis; really it was a diagnosis, as he claims: 'Nomen specificum est itaque differentia essentialis.' This was his boast: 'Primus incepi nomina specifica es-

sentialis condere, ante me nulla differentia digna exstitit.' What is now known as a binomial name was called by Linnæus a 'nomen triviale,' and he regarded it as of trivial importance. Indeed, he contemptuously accredited his predecessors with the use of such; he expressly affirmed, 'Trivialia erant antecessorum et maxime trivialia erant antiquissimorum botanicorum nomina.'

In the 'Systema Naturæ,' the 'nomen specificum,' or diagnosis, was given the prime place in the text in connection with each species under the generic diagnosis, and the 'nomen triviale' was thrown in on the margin of the page so that it should readily catch the eye. The treatment of one and the same genus by Linnæus in the 'Systema Naturæ,' by Artedi in his 'Genera Piscium,' and by Walbaum in his edition of Artedi's work, will illustrate. *Cobitis,* the second of the Artedian genera, will do.

By Linnæus, the species were thus named:

149. COBITIS. [Diagnosis follows.]

| | |
|---|---|
| Anableps. | 1. C. capite inermi depresso, oculis prominulis. |
| Barbatula. | 2. C. cirris oris 6, capite inermi compresso. |
| Taenia. | 3. C. cirris oris 6, spina suboculari. |
| fossilis. | 4. C. cirris oris 8, spina supra-oculari. |

These corresponded to the three species of Artedi named by him as follows:

1. Cobitis *aculeo bifurco infra utrumque oculum* [etc.] (*a*).

2. Cobitis *tota glabra maculosa* [etc.] (*b*).

3. Cobitis *coerulescens;* [etc.] (*c*).

In footnotes, Walbaum coordinates these with the Linnæan names as follows:

(*a*) 1. Cobitis, *Taenia,* cirris 6; spina suboculari. *L. S. N.* 499.

[Diagnosis follows.]

(*b*) 2. Cobitis *Barbatula,* cirris 6; capite inermi, compresso. *L. S. N.* 499.

[Diagnosis follows.]

(*c*) 3. Cobitis, *fossilis,* cirris octo; spina superoculari. *L. S. N.* 500.

[Diagnosis follows.]

Walbaum then added several later discovered species and continued the numeration from the Artedian system. The additions were:

4. Cobitis, *Anableps;* Vide in sequentibus genus Anableps *Artedi.*

The reference is to page 160, where Walbaum calls the species 'Cobitis, *Anableps'* [etc.], refusing to adopt the genus *Anableps.*

5. Cobitis, *heteroclita,* capite imberbi; [etc.].

6. Cobitis, *japonica. Iapanse Meirshlang. Hoattuyn* [Houttuyn, etc.].

After these he added several species he considered for the present doubtful (*'Species adhuc dubiae'*), but continued the numeration:

7. COBITIS, *macrolepidota,* albo fasciata. *W.*

8. COBITIS, *majalis,* nigro in longitudinem et ad caudam transversim lineatus. *W.*

These species are at present mostly known by the following names:

1. Cobitis taenia.
2. Nemochilus barbatula.
3. Misgurnus fossilis.
4. Anableps anableps.
5. Fundulus heteroclitus.
6. Saurida argyrophanes?
7. Fundulus heteroclitus macrolepidotus.

Now it will appear, from a comparison of the names used by Walbaum and Linnæus, that Walbaum acted more in conformity with the present usage of naturalists than did Linnæus. He placed the 'nomen triviale' immediately after the generic name and before the diagnosis, indicating its character by italics generally and its interposition between the generic name and 'nomen specificum' or diagnosis, by commas. In other words, Walbaum interpolated the 'nomen triviale,' while Linnæus was wont to put it by the side.

The 'Genera Piscium' was well edited by Walbaum (or Wallbaum, as he often called himself). He gave the text as it was left by Linnæus and indicated the original pages by marginal numbers. He brought the work up to date by additions given in foot-names, which consequently greatly added to the volume. He has been recognized by all authors as a binomialist till Mr. Fowler challenged his right to be considered such, and a binomialist he certainly was.

In the typographical expression of the

synonymy of the species mentioned, Mr. Fowler has committed an assault upon typographical custom which ought almost to have caused a strike among the printers and must have excited the disgust of the proof-reader. Such a monstrosity as '*C.(ephaloptera) vampyrus,*' or even '*(Raja.) Manatia,*' unhappily, is not unparalleled, but because it is not, and a bad example had been set before, a protest now is all the more timely. Some deference should be paid to the reader, and if he is not intelligent enough to know that *C[ephaloptera] vampyrus* is the full expression of *C. vampyrus*, and that the bracketed letters were substituted for the period, indicating abbreviation, he certainly would not be intelligent enough to appreciate any part of the article in question. Such flagrant abuses of typographical methods should not be tolerated. The first volume of an otherwise excellent work by a distinguished naturalist was recently published marred by similar blemishes, but the author relieved himself of such eccentricities in the succeeding volume. It is to be hoped that Mr. Fowler will profit by the later example in the same measure as he was misled by the former.

It is proper to add that Mr. Fowler and his predecessor were simply actuated by a laudable desire for perfection of quotation in their strange typographical devices, but surely there should be some limit to deviation from customary methods and to pandering to ignorant and incompetent students.

THEO. GILL.

COSMOS CLUB, WASHINGTON.

### THE NEW MEXICO NORMAL UNIVERSITY.

THE whole faculty of the New Mexico Normal University resigns at the end of the present school year, under circumstances which should be widely known. Predatory organizations of a political character exist in New Mexico as elsewhere, and it is in the nature of things that they should interfere in various ways and degrees with educational institutions. During my connection with the New Mexico Agricultural College (1893-1900) I had many opportunities for learning the character and motives of this interference, and the time may come when it will be expedient to tell the story in some detail. Some idea of the prevalent conditions may be gathered from the fact that within a period of eight years (1894-1901) the college had five successive presidents, namely, Hadley, McCrea, Jordan, Sanders and Foster. In spite of everything, a great deal of good and useful work was done; but it was lamentable to see the waste of opportunity, time and money resulting from the actions of self-interested, ignorant and prejudiced people. I have before me copies of the letter of Dr. Sanders, fourth president of the college, to his board of regents, and of his second annual report, both written in 1901. In these carefully prepared and exceedingly outspoken documents the case against the politicians is presented in the clearest manner, with abundant details; but they are too voluminous to be published in SCIENCE.

The Turkish have a proverb: 'The fish stinks from the head.' It can not be overlooked that the governors of New Mexico, who appoint the regents of the higher institutions, are responsible for the generally unsatisfactory character of these bodies. It is pertinent to ask why the presidents of the United States have not, at least within recent years, seen it possible to give us even tolerably good governors. The explanation lies, of course, in the so-called policy of home rule, which in this case results in practically giving the appointment of the chief executive into the hands of the then dominant predatory organization. It would seem more logical either to make us a state and let us make our own muddle, or treat us as a child-commonwealth and provide us with competent rulers.

The New Mexico Normal University, which opened its doors five years ago, has had until now a most fortunate immunity from political interference. In spite of its rather ridiculous name, it has prospered under the guidance of men who understood its proper aims and needs. This has been principally due to the wisdom and influence of Mr. Frank Springer, the well-known authority on crinoids, who has been president of the board of regents. Mr. E. L. Hewett, the president of the school, is a well-

known educator and student of anthropology. The faculty has been chosen by the president, and elected to serve indefinitely on good behavior, instead of being reelected annually as at the Agricultural College. In so young a school much remained for the future, but progress has been steady and satisfactory, and the institution was beginning to amount to something as a scientific center.

All this is now to be changed. All along there had been attempts within and without the board of regents to effect undesirable changes, but so far it had been possible to suppress them, and the faculty usually heard nothing of them. However, when a member of the board recently resigned because he was leaving New Mexico, Governor Otero appointed for the unexpired term a man who was well known to be hostile to the existing management. After a time it became plain that a destructive policy was intended, and Mr. Springer resigned from the board. The faculty held a meeting to discuss the situation, and sent one of their number to represent the facts to Governor Otero. The governor, however, offered no relief and plainly intimated that if we resigned there were plenty more where we came from. It was then decided to lay the matter before the public, and a printed pamphlet was issued, setting forth the conditions in detail. This was well received by the public and the students, the great majority siding with the faculty; the students especially being practically unanimous, and passing resolutions expressing their opinions. The City Council of Las Vegas also passed resolutions in favor of the faculty. In the face of all this, however, Governor Otero reappointed the regent objected to for a full term, and appointed in Mr. Springer's place one of the regular politicians. In these actions he was supported by the council of the recent New Mexico legislature, which has been exceptionally corrupt and incompetent. Hence the faculty goes.

T. D. A. COCKERELL.

LAS VEGAS, N. M.,
April 12, 1903.

## SHORTER ARTICLES.

### THE USE OF PNEUMATIC TOOLS IN THE PREPARATION OF FOSSILS.

THE tedious work of removing fossils from their matrix by means of the hammer, chisel and awl has led to various experimentation with machine tools in the hope of devising some more rapid method. The dental engine and the electric mallet have been in use in some laboratories for a number of years, and have proved very efficient in such work as the removal of hard matrix from small skulls. However, their efficiency has so far been limited to light work. This is probably due in a large part to the fact that the tools used are those constructed for the lighter work of dentistry. It is also generally conceded that electric appliances have not proved a success in percussion tools.

Pneumatic tools were introduced into the paleontological laboratory at the Field Columbian Museum by the writer some four months ago, and may now be said to have passed through the experimental stage. The application of these tools to fossil-cleaning has proved so successful that it has seemed worth while to call attention to their use in this work.

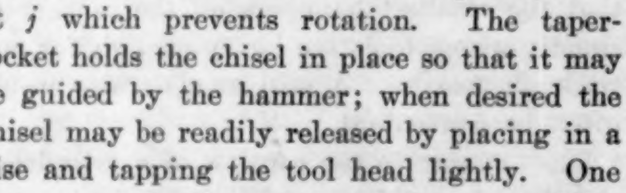
The pneumatic hammer as used in chipping and riveting metals and in stone-cutting is too well known to require description here. However, only the lightest hammers used in stone-cutting come within range of our present consideration. These are manufactured by a number of firms in the United States and are of two types, the pistol-grip and the straight cylinder. The latter type has been adopted by the writer on account of greater convenience in bringing the tool into use in work in all positions. Experimentation has shown that the smallest hammers on the market as stone working tools are heavy enough for any work on fossils. A still smaller size would often be convenient.

The hammer in use consists of a cylindrical chamber in which a five-eighth-inch steel plunger having a five-eighth-inch stroke is caused to play upon the head of the chisel at the rate of 3,000 to 3,500 strokes per minute.

This rapid succession of light blows sets up a vibration in the chisel, which, with even a slight pressure against the work, gives it a remarkable cutting capacity. In fact a chisel so driven will cut an indurated clay as rapidly as an ordinary hand tool will cut chalk.

The chisels commonly used in stone cutting are made uniformly of one-half-inch square or octagon steel about nine inches in length. Of these one and one half inches of the head end is turned down to three-eighth-inch diameter, so as to fit into the chamber of the tool and provide the shoulder necessary to hold the chisel at the precise point which will render the stroke of the hammer most effectual. These chisels are used indiscriminately in all sizes of stone hammers and are ill adapted for the preparation of fossils. The requisite for such delicate work is a keen stroke under complete control. This has been in a measure attained by fitting an attachment to the stone cutting hammer.

In the accompanying figure *a* represents the plunger, *b* the hard steel barrel and *c* the softer outer jacket of the hammer. A tempered steel cylinder *d* is attached to *c* by a heavy thread; this holds in position a separate tool head *e*, which receives the blow of the hammer and bears the chisel *f* in a taper socket. A coil spring *g* acting against the shoulders *h* and *i* in turn receives the blow of the hammer or any part of it not util-



Cross-section of Pneumatic Hammer, with Tool-holding attachment.

ized in work at the point of the chisel. The tool head *e* is fitted to a square opening in *d* at *j* which prevents rotation. The taper-socket holds the chisel in place so that it may be guided by the hammer; when desired the chisel may be readily released by placing in a vise and tapping the tool head lightly. One escape-vent is directed forward so as to blow away dust and small chips from the work. For chisels, one-fourth-inch round steel cut in six-inch lengths and drawn to a point of one-eighth or three-sixteenth inch in breadth are most efficient. For finishing, a broader bladed chisel may be used to advantage.

This appliance makes it possible to dispense with the unnecessary weight of metal in the chisel so that a keener stroke and a greater cutting capacity result. At the same time the manipulator is relieved of the necessity of holding the chisel in place with the left hand and so avoids the benumbing jar caused by the vibration.

The advantages of this hammer over the old-fashioned hammer and chisel are its much greater cutting capacity and its freedom from the jar which causes so much breakage in specimens encased in hard matrix. The relative cutting capacity depends upon the nature of the material to be removed. If it be sandstone, by which tools are rapidly dulled, blocking off in large pieces by means of hammer and chisel will be found more expedient. Or if it be a very hard substance, such as quartz or chalcedony infiltrations, a method of spalling by means of a square-poled hammer may prove more efficient than either. But in limestone or any of the indurated clays the superiority of the pneumatic hammer is at once evident. This is especially true in the case of complicated specimens where there are deep cavities or foramina to be developed. In such work the pneumatic chisel can be used wherever its point can be introduced, while with the old-fashioned hammer and chisel one is often at a loss for room to hold and strike. The cutting capacity of a chisel is much greater also when used with the pneumatic hammer, as the point can be made much harder without danger of breaking. Chisels made from a high grade English steel of 1.4 per cent. carbon chilled to a file-like hardness may be used four or five hours in concretionary clays without need of grinding.

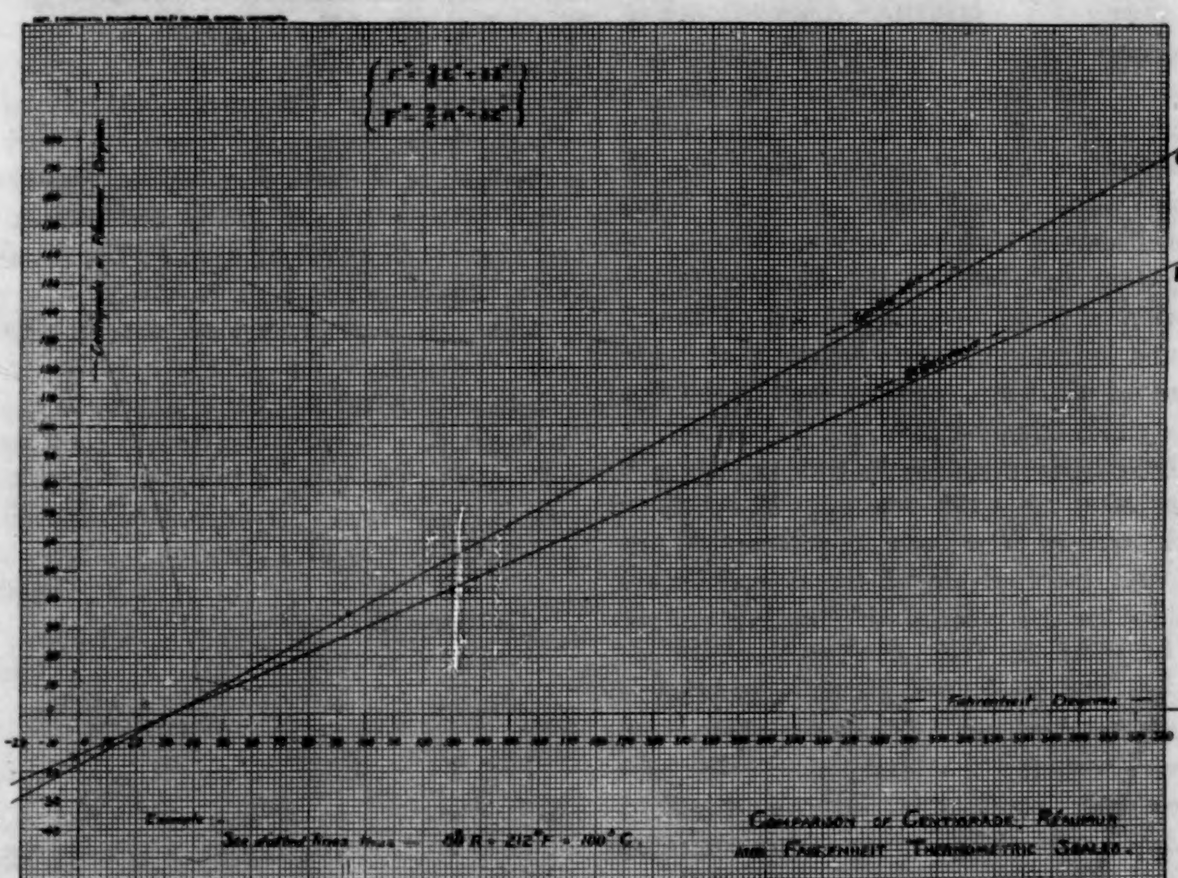
The advantage of relieving the specimen from the jar of the hand-hammer can scarcely be overestimated. In working out dinosaur vertebræ from a concretionary matrix by means of hand tools we have often found it necessary to break the specimen to pieces with a hammer in order to remove the chalcedony-filled masses of concretion from the

cavities. The use of the pneumatic chisel has made it possible to remove the matrix from such cavities, with but little injury to the specimen. The tendency to chip off thin edges with flakes of the matrix is also avoided.

Skill in the use of these tools is readily acquired. By adapting the size of the chisel to the work in hand and gauging the amount of air admitted to the tool by means of a push-button throttle valve, the stroke can be reduced so that a scale may be removed from the most delicate surface.

E. S. RIGGS.

FIELD COLUMBIAN MUSEUM.




THERMOMETRIC READINGS.

HAVING had frequently occasion to transfer thermometric readings given in one of the common systems, Centigrade, Fahrenheit and Réaumur, into one of the others, the accompanying diagram has been developed, which affords a convenient and rapid means of such transformation, and is adequate, provided a high degree of accuracy is not desired. The relations between the three systems are given by the following formulæ:

$$F.^\circ = \tfrac{9}{5} C.^\circ + 32^\circ = \tfrac{9}{4} R.^\circ + 32^\circ.$$

Fahrenheit degrees being plotted along a horizontal axis, and Centigrade or Réaumur degrees along a vertical axis, the graphs of the two equations above give two straight lines, as shown, from which, having given a reading in one of the systems, the corresponding reading in either one of the other two may be obtained.

Thus to find the equivalent of 80° R. the horizontal from the 80° division on the vertical axis is followed to its intersection with the line marked Réaumur, thence downward where the corresponding Fahrenheit reading (212° F.) is found on the horizontal axis; or upward to 'Centigrade' line and thence horizontally to left where the corresponding Centigrade reading (100° C.) is found on the vertical axis.

Both lines cross the horizontal, or Fahrenheit, axis at the same point, 32°; the Réaumur

line having a slope of $\frac{9}{4}$, the Centigrade line a slope of $\frac{4}{5}$.

The diagram is capable of being extended as far as may be desired, and by shifting the origin of coordinates and choosing a suitable scale of magnification, almost any desired degree of accuracy may be obtained for readings along any given part of the diagram.

S. W. Dudley.

Sheffield Scientific School,
Yale University,
February 7, 1903.

DISCOVERY OF DENTAL GROOVES AND TEETH IN THE TYPE OF BAPTANODON (SAURANODON) MARSH.

Through the courtesy of Dr. C. E. Beecher the writer has recently enjoyed the privilege of studying the types in the Yale Museum on which Professor O. C. Marsh based the description of *Baptanodon natans* and *B. discus*.

The discovery * of teeth in the jaws of an Ichthyosaurian (No. 603) belonging to the collection of fossil vertebrates of the Carnegie Museum, led the author to believe that dental grooves, if not teeth, were present in the type of the genus *Baptanodon*.

Only a little preparation was necessary to demonstrate the existence of well-developed dental grooves on both upper and lower jaws, and just outside of the dental groove, imbedded in the matrix surrounding the rostrum of No. 1952† (type of the genus), a small tooth was discovered. This tooth is Ichthyosaurian in character. The enameled crown, however, is perfectly smooth, there being present no such longitudinal striæ as those observed on the teeth belonging to No. 603 of the Carnegie Museum. The complete preparation of No. 1952 would undoubtedly reveal other teeth. Professor Marsh's statement, that 'the jaws appear entirely edentulous and destitute even of a dentary groove,' was doubtless due to the imperfectly prepared material upon which he based his first description.

* 'Discovery of Teeth in Baptanodon, an Ichthyosaurian from the Jurassic of Wyoming,' Science, N. S., Vol. XVI., No. 414, December 5, 1902, pp. 913–914.

† Catalogue number of the Yale Museum.

The presence of teeth in the type of *Baptanodon*, as well as their existence in two specimens preserved in the collections of this museum, clearly demonstrates the fact that American Ichthyopterygians possessed teeth. This fact, now firmly established, makes it still more difficult to separate the genus *Baptanodon* from the closely allied European form *Ophthalmosaurus*, and unless other distinguishing characters can be found they will necessarily have to be considered as generically identical. *Baptanodon* would then become a synonym of *Ophthalmosaurus*.

In my first paper I provisionally proposed the new genus *Microdontosaurus*, using as the type No. 603 of the Carnegie Museum collections. I then distinguished this genus from *Baptanodon* by the supposedly edentulous character of the latter. Since, however, *Baptanodon* has been conclusively demonstrated to have possessed teeth *Microdontosaurus* must be abandoned as a synonym of *Baptanodon* or *Ophthalmosaurus*.

Since some time must necessarily elapse before the publication of the final paper upon which the writer is now engaged, it has been thought best to call attention to the discovery of teeth in the type of the genus *Baptanodon*, which has been considered edentulous for nearly a quarter of a century.

Charles W. Gilmore.

Carnegie Museum,
April 4, 1903.

THE BITTER-ROT FUNGUS.

In 1854 Berkeley (*Gardener's Chronicle*, p. 676) described a fungus, *Septoria rufomaculans* n. sp., growing on grapes. He renamed this in 1860 ('Outlines of British Fungology,' p. 320), calling it *Ascochyta rufomaculans* Berk. In 1879 von Thümen ('Fungi Pomicoli,' p. 59) placed this fungus in the genus *Glœosporium* and it then became *Glœosporium rufomaculans* (Berk.) von Thümen. In 1856 Berkeley (*Gardener's Chronicle*, p. 245) described a fungus causing a rot of apples, naming it *Glœosporium fructigenum* n. sp. This is the fungus which is the cause of the bitter-rot disease of apples which has caused such extensive damage to apple crops for many

years. It has now been shown that the *Glœosporium* on grape and the *Glœosporium* on apple are one and the same fungus, and this fungus has by common consent been called *Glœosporium fructigenum* Berk. In 1902 Clinton ('Bulletin Illinois Agricultural Experiment Station,' 69:193–211, III.) described the perfect stage of this fungus and placed it in the genus *Gnomoniopsis* established by Miss Stoneman (*Botanical Gazette*, 26:71–74, 99–101, 113–114) in 1898, making the name for the bitter-rot fungus *Gnomoniopsis fructigena* (Berk.) Clinton. Recent studies have shown that the name *Gnomoniopsis* applied to the perfect forms of several species of *Glœosporium* and *Colletotrichum* by Miss Stoneman in 1898 was used by Berlese in 1892 ('Icones Fungorum,' p. 93) for a very different group of fungi. The genus name *Gnomoniopsis* Stoneman is, therefore, invalidated, and a new name must be given to the fungi included until now under that name. The writers propose the name *Glomerella*, in which the following species can up to the present time be included:

*Glomerella cingulata* (Atk.) Spaulding & v. Schrenk.

*Glomerella piperatum* (E. & E.) Spaulding & v. Schrenk.

*Glomerella cinctum* (B. & C.) Spaulding & v. Schrenk.

*Glomerella rubicolum* (E. & E.) Spaulding & v. Schrenk.

To the above the bitter-rot fungus must be added. As the name *Glœosporium rufomaculans* and *Glœosporium fructigenum* apply to the same fungus, and as *Glœosporium rufomaculans* antedates *Glœosporium fructigenum* the new name for the bitter-rot fungus becomes *Glomerella rufomaculans* (Berk.) Spaulding & von Schrenk, with the following synonyms:

*Glomerella rufomaculans* (Berk.) Spaulding & von Schrenk.
*Septoria rufomaculans* (Berk.) 1854.
*Ascochyta rufomaculans* (Berk.) 1860.
*Glœosporium rufomaculans* (Berk.) von Thümen, 1879.
*Glœosporium fructigenum* (Berk.) 1856.
*Glœosporium læticolor* (Berk.) 1859.
*Glœosporium versicolor* (Berk. & Curt.) 1874.
*Gnomoniopsis fructigena* (Berk.) Clinton, 1902.

HERMANN VON SCHRENK,
PERLEY SPAULDING.
U. S. DEPT. OF AGRICULTURE.
MISSOURI BOTANICAL GARDEN.

## *QUOTATIONS.*

### THE INDEX MEDICUS.

WE are informed on good authority that the 'Index Medicus,' the first number of which under the new auspices has just appeared, is not receiving its due support, that 251 copies cover the entire subscription list among the profession, both abroad and in this country. That would bring in a return of only $1,255, with an expenditure of about $12,000 per annum. The Carnegie Institution has generously devoted $10,000 per annum to the publication of the index for three years and it was intended to continue this indefinitely, provided sufficient interest is shown in this enterprise, which has in the past redounded so much to the credit of our country. The 'Index Medicus' should go to every place where at least an attempt at clinical or research work is being done, to every insane asylum, to every large hospital, to every medical educational institution, and, in our opinion, it is almost an indispensable adjunct to the editorial work of every medical journal worthy of the name. If it can receive subscriptions from each of these sources, it would not only relieve the Carnegie Institution of its expense, but furnish a considerable surplus for its enlargement and increased usefulness. It is not an American publication alone. It should receive equal patronage from every part of the world. It is just as discreditable, if not more so, that its subscription list from abroad is not more than double or treble what it is in this country. No person who is interested in medical literature, no one who is attempting to do original work, can wilfully dispense with the aids it can offer. The fault of much of the work that has been done and is still being done throughout the world, especially in some of the insti-

tutions in this country, is that so little is known of what others are doing and, consequently, a great deal of human effort is needlessly wasted. Much sciolistic conceit would be also avoided if this publication, with its preceding series and additional data from the 'Index Catalogue,' could be properly utilized, and medical literature would be a far more satisfactory thing than it is at present. Brown-Sequard, the celebrated French physiologist, used to bitterly complain of the amount of rediscovery of his work that he was constantly seeing in the German literature. It is only by such bibliographies as the 'Index Medicus' that much of this can be avoided. We hope the subscription list will be at least quadrupled. The very moderate subscription price, $5, puts it within the reach of everyone who is attempting to do any medical literary work, and no one should attempt that without having at least access to its aid. We do not believe in multiplication of references or unnecessarily elaborate bibliographies, and the rule of verifying one's references by the originals, of course, is a good one to be followed, but there is no better first guide to medical literature than the 'Index Medicus' as now presented to the profession.—*Journal of the American Medical Association.*

### THE PRESIDENCY AT THE UNIVERSITY OF VIRGINIA.

The University of Virginia, after adhering for over eighty years to the plan of government devised by its founder, Thomas Jefferson, now decides to conform to the practice of other American universities and to elect a president. From the names suggested for the office it may be inferred that it is a 'business' president that is wanted. No doubt, the trustees of the university know best the needs of the institution, and it may be that in the modern competition in education it is necessary to sacrifice individual characteristics. An enlightened despotism, more or less tempered by trustee or overseer supervision, can accomplish much in a short time from both the financial and the educational points of view, as Harvard shows. It is possible, therefore, that the change may bring immediate prosperity to the University of Virginia.

All the same, regret must be felt that a system devised by the great Democrat with the deliberate purpose of eliminating the one-man power, a system that has proved efficient and successful in its scholarly results and in the character of the men trained under it, should disappear in the modern craving for uniformity and for quick material gains.—New York *Sun.*

## *CURRENT NOTES ON METEOROLOGY.*

### GENERAL CIRCULATION OF THE ATMOSPHERE.

An important publication is the report on the general circulation of the atmosphere, prepared by Dr. Hildebrandsson as Part I. of the 'Rapport sur les Observations internationales des Nuages' for the International Meteorological Committee (Upsala, 1903, large 8vo., pp. 48, pls. XXII.). This is a brief historical presentation of the theories of the general circulation of the atmosphere advanced by Dove, Maury, Ferrel and Thomson, and an examination of the results of cloud observations made at stations in different parts of the world in their bearing on these theories. These results, which include the latest and best obtainable, are presented graphically in a series of twenty-two charts, for stations selected because of their position in certain critical latitudes. Thus, among these stations are found the following: San José de Costa Rica; 'Square No. 3' (Lat. 0°–10° N.; Long. 20°–30° W.); Manila; Mauritius; San Fernando and Lisbon; Havana; Lahore, Allahabad and Calcutta; Kurrachee, Bombay and Cuttack; Blue Hill; Paris; several in England, Germany and Denmark; Upsala, and others in Sweden, Norway, Siberia, China, Japan. Dr. Hildebrandsson, as is well known, has already done most important work in his study of cloud forms and cloud measurements, and he has been one of the moving spirits in the international investigation of cloud heights and velocities. He is, therefore, the meteorologist who is perhaps best fitted to undertake the discussion in hand, and his conclusions, which are based on a thorough study of data carefully compared and digested, will be received with satisfaction and accepted with confidence. So important are some of these conclusions in their bearing on

the theory of the general circulation of the atmosphere as put forward by Ferrel and Thomson, and as adopted in all the newer text-books, that it seems well to give here a translation of Dr. Hildebrandsson's summary (pp. 47–48 of the report):

"By means of direct observations the following results have been obtained: (1) Above the heat equator and the equatorial calms there is, throughout the year, a current from the east which seems to have very high velocities at great altitudes. (2) Above the trades there is an anti-trade from S. W. in the northern, and from N. W. in the southern hemisphere. (3) This anti-trade does not extend beyond the polar limit of the trade; it is deflected more and more to the right in the northern, and more and more to the left in the southern hemisphere, and finally becomes a current from the west above the crest of the tropical high pressure belts, where it descends to supply the trades. (4) The districts at the equatorial margin of the trades are partly in the trades and partly in the equatorial calms, according to the season. Above them there is, therefore, an upper monsoon: the anti-trade in winter, and the equatorial current from the east in summer. (5) From the tropical high pressure belts the air pressure on the whole decreases continuously towards the poles, at least to beyond the polar circles. Further, the air of the temperate zone is drawn into a vast 'polar whirl' turning from west to east. This whirling movement seems to be of the same nature as that in an ordinary cyclone: the air of the lower strata approaches the center, while that of the higher strata tends out from the center, and this outward tendency increases with the altitude above sea level as far up as the greatest altitudes from which we have observations. (6) The upper currents of the atmosphere in the temperate zones extend over the tropical high pressure belts, and descend there. (7) The irregularities which are noted at the earth's surface, especially in the regions of the Asian monsoons, as a whole disappear at the lower or intermediate cloud levels. (8) We must entirely abandon the notion of a vertical circulation between tropics and poles which has up to this time been accepted in accordance with the theories of Ferrel and Thomson."

This 'vertical circulation,' to which allusion is made, refers to the view that the air, ascending near the equator, flows as an upper current across the tropical high pressure belts to the circumpolar regions, and thence returns as an intermediate current from the poles towards the equator. It is in regard to this point that the conclusions of Dr. Hildebrandsson are most interesting. Dr. Hildebrandsson expressly states that he simply presents facts, and does not discuss theories. But he does say most emphatically (p. 44): "*Il faut donc abandonner une fois pour toutes cette idée d'une circulation verticale entre les tropiques et les poles,*—circulation qui semble du reste impossible pratiquement dans une couche dont l'épaisseur est très petite en comparison avec les distances horizontales. Espérons que dès à présent ces 'courants polaires' et 'équatoriaux,' qui ont fait tant de confusion dans la météorologie dynamique, disparaîtront enfin complètement de la science météorologique, au moins dans le sens dans lequel on les a adoptés jusqu'ici."

R. DEC. WARD.

## THE LIGHT OF NOVA GEMMORUM.

THE light of Nova Gemmorum appears to be fluctuating like that of Nova Persei No. 2. On the evening of May 1 it appeared that its light had increased about half a magnitude during the preceding twenty-four hours. Since the measures described in the *Astronomical Bulletin* of April 22, similar measures were obtained on April 24, 25, 27, 28, 29, 30 and May 1, and gave the magnitudes 9.37, 9.67, 9.71, 9.81, 9.61, 9.76 and 9.26 respectively.

EDWARD C. PICKERING.

## BRAIN-WEIGHT, CRANIAL CAPACITY AND THE FORM OF THE HEAD, AND THEIR RELATIONS TO THE MENTAL POWERS OF MAN.

DR. H. MATIEGKA, in Part I. of his extensive studies on this subject,* has published some

* 'Ueber das Hirngewicht, die Schädelkapacität und die Kopfform, sowie deren Beziehungen zur psychischen Thätigkeit des Menschen,' *Sitzb. d. kön böhm. Ges. d. Wiss.*, II. Classe, Article XX., 1902.

new and interesting facts concerning the weight of the human brain. His material and data were gathered in the Bohemian Institute of Pathological Anatomy and in the Institute of Forensic Medicine, and were subjected to a careful analysis with reference to age, sex, stature, race, muscular and skeletal development, state of nutrition, mental state, occupation, cranial capacity and form, and the mode of death. The work is exhaustive, and hardly permits of suitable abstraction in a limited space. Only a few of the most interesting results may be quoted here.

The heaviest male brain (1,820 gms.) was that of a young man, age 22, of large stature (180 cm.) and powerful build, well-nourished; suicide by drowning. The heaviest female brains, three in number, weighed 1,500 gms. The lightest female brain, from an individual of middle age (25 years), weighed 1,020 gms., with a stature of 150 cm.; cause of death, hemorrhage from a stab-wound of the lung. The brain of a senile female (age, 89) weighed 1,000 gms. The average weight (or as Matiegka specifies, '*der Kulminationspunkt*') of males aged 20 to 59 is 1,400 gms.; of females, 1,200 gms.

Among recent brain-weights of notable persons, Matiegka mentions that of Konstantinoff, a Bulgarian novelist, 1,595 gms.; F. Smetana, the insane composer, 1,250 gms. (atrophy of paralytic dementia); J. G. Kolár, a Bohemian dramatic writer, 1,300 gms. (age, 84 years; senile atrophy), and Marie Bittner, a talented actress, age 44, 1,250 gms. (about 45 gms. above the average). The skull of P. J. Šavařík, the noted Slavist, had a capacity of 1,738 c.c., which, with Manouvrier's coefficient 0.87, gives an estimated brain-weight of 1,512 gms.

One of the most interesting chapters in Matiegka's monograph concerns the relations of brain-weight and occupation. For this analysis he had 235 brain-weights at his disposal, which he arranged in six groups, ascending from the ordinary day-laborers, who never could learn a trade or remain steadily employed, to those of considerable mental ability. The table is here reproduced in condensed form:

| | No. of Cases. | Average Brain-weight. |
|---|---|---|
| Group I. Day-laborers ......... | 14 | 1,410.0 |
| " II. Laborers ............ | 34 | 1,433.5 |
| " III. Porters, watchmen, etc. ............ | 14 | 1,435.7 |
| " IV. Mechanics, trades-workers, etc. ....... | 123 | 1,449.6 |
| " V. Business-men, teachers, clerks, professional musicians, photographers, etc.. | 28 | 1,468.5 |
| " VI. Men of higher mental abilities, presupposing a collegiate education, such as scholars, physicians, etc. ............... | 22 | 1,500.0 |

Persons employed in clothing industries, who are apt to be poorly nourished and not very muscular, show a lower brain-weight, 1,433.6 gms. Carpenters (11 cases) have 1,441.8 gms.; coachmen and truck-drivers (14 cases), 1,445.7 gms. Blacksmiths, locksmiths and metal-workers in general, who are as a rule muscular and well-nourished, have a higher brain-weight (21 cases) 1,476.7 gms. Persons occupied in the manufacture and sale of alcoholic beverages (brewers, tavern-keepers, waiters, etc.) have a low brain-weight (16 cases), 1,416.9 gms., doubtlessly due to the large proportion of drinkers among them.

These results are indeed striking and significant, and while they may be challenged as being based upon an insufficient number of cases, the method of the analysis employed by Matiegka is worthy of wide-spread adoption in anatomical institutes everywhere.

E. A. SPITZKA.

## THE ST. LOUIS CONGRESS OF ARTS AND SCIENCES.

WE begin on Monday, the 19th of September, 1904, late enough to avoid the tropical summer heat of St. Louis, and early enough still to make use of the university vacations. On Monday morning the subject for the whole congress is knowledge as a whole, and its marking off into theoretical and practical knowledge. Monday afternoon the seven divisions meet in seven different halls; Tuesday the seven divisional groups divide them-

selves into the twenty-five departments, of which the sixteen theoretical ones meet in sixteen different halls on Tuesday morning, and the nine practical, on Tuesday afternoon. In the following four days the departments are split up into the sections; the seventy-one theoretical sections meeting on Wednesday, Thursday, Friday, Saturday, about eighteen each morning in eighteen halls, and the fifty-nine practical sections on the same days in the afternoons, the arrangement being so made that sections of the same department meet as far as possible on different days, every one thus being able to attend in the last four days of the first week the meetings of eight different sections, four theoretical and four practical ones, in the narrower circle of his interests. In the second week a free sub-division of the sections is expected, and, moreover, a number of important independent congresses, as, for instance, an international medical congress, an international legal congress, and others, are foreseen for the following days. These independent congresses will highly profit from the presence of all the leading American and foreign scholars, whose coming to St. Louis will be secured by the liberal arrangements of the official congress in the first week; on the other hand, these free congresses represent indeed the logical continuation of the set work of the first seven days, as they most clearly indicate the further branching out of our official sections, leading over to the specialized work of the individual scholars. And yet this second week's work must be, as viewed from the standpoint of our official congress, an external addition, inasmuch as its papers and discussions will be free independent contributions not included in the one complete plan of the first week, in which every paper will correspond to a definite request. The official congress will thus come to an end with the first week, and we shall indicate it by putting the last section of the last department, a section on religious influence in civilization, on Sunday morning, when it will not be, like all the others on the foregoing days, in competition with fifteen other sections, and may thus again combine the widest interests. In this section there will be room also for the closing exercises of the official occasion.

The arrangement of the sciences in days and halls is however merely an external aspect. We must finally ask for the definite content. Our purpose was to bring out the unity of all this scattered scientific work of our time, to make living in the world the consciousness of inner unity in the specialized work of the millions spread over the globe. The purpose was not to do over again what is daily done in the regular work at home. We desired an hour of repose, an introspective thought, a holiday sentiment, to give new strength and courage, and, above all, new dignity to the plodding toil of the scientist. Superficial repetitions for popular information in the Chautauqua style and specialistic contributions like the papers in the issues of the latest scientific magazines would be thus alike unfit for our task. The topics which we need must be those which bring out the interrelation of the sciences as parts of the whole; the organic development out of the past; the necessary tendencies of to-day; the different aspects of the common conceptions; and the result is the following plan:

We start with the three introductory addresses on 'Scientific Work,' on the 'Unity of Theoretical Knowledge,' and on the 'Unity of Practical Knowledge,' delivered by the president and the two vice-presidents. After that the real work of the congress begins with a branching out of the seven divisions. In each one of them the topic is fundamental conceptions. Then we resolve ourselves into the twenty-five departments, and in each one the same two leading addresses will be delivered; one on the development of the department during the last hundred years, and one on its methods. From here the twenty-five departments pass to their sectional work, and in each of the one hundred and thirty sections again two set addresses will be provided; one on the relations of the section to the other sciences, one on the problems of to-day; and only from here does the work move during the second week into the usual channels of special discussions. We have thus during the

first week a system of two hundred and sixty sectional, fifty departmental, seven divisional, three congressional addresses which belong internally together, and are merely parts of the one great thought which the world needs, the unity of knowledge.—Professor Hugo Münsterburg in the *Atlantic Monthly.*

## SCIENTIFIC NOTES AND NEWS.

During the week beginning June first, Professor J. J. Thomson, F.R.S., Cavendish professor of experimental physics in the University of Cambridge, will give a course of lectures in the Physical Laboratory of the Johns Hopkins University on 'A Theory of the Arc and Spark Discharges.'

Professor Klement Arkadijevic Timirjazev, professor of botany at Moscow, gave the Croonian lecture before the Royal Society on April 30, his subject being 'The Cosmical Function of the Green Plant.'

The University of Glasgow has conferred the degree of Doctor of Laws on Sir Norman Lockyer, director of the Solar Physics Observatory, South Kensington, and editor of *Nature;* Dr. Thomas Oliver, professor of physiology in the University of Durham, and Mr. Philip Watts, director of naval construction at the Admiralty.

The University of Dublin has conferred the degree of Doctor of Science on Sir William Abney, F.R.S., assistant secretary of the British Board of Education, known for his work on photography and color vision.

We learn from *Nature* that M. Lippmann is to succeed M. Poincaré as president of the French Astronomical Society this month. M. Janssen has been elected *president d'honneur.* The society's prize has been awarded to M. Charlois for the discovery of a large number of minor planets, and the Janssen prize to M. Giacobini for the discovery of seven comets.

Professor Ralph W. Tower, of Brown University, associate professor of chemical physiology, has been elected head of the department of physiology and curator of the books and publications in the American Museum of Natural History in New York City.

Mr. Sidney D. Townley has been placed in charge of the International Latitude Observatory at Ukiah, Cal.

Mr. Hugh H. Bennett, assistant in the Chemical Laboratory, University of North Carolina, has accepted the position of assistant in the Chemical Laboratory, Division of Soils, U. S. Department of Agriculture.

Dr. Capitan has been made a member of the committee on historic and scientific works of the French ministry of public instruction, in room of the late M. Bertrand.

Mr. F. A. Delano, general manager of the C. B. and Q. R. R., gave an address before the engineering students of Purdue University upon 'The Comparative Development of American and European Railways,' on April 13.

Drs. William H. Welch and William Osler gave a dinner at the Maryland Club, April 18, to Dr. Robert Fletcher, of Washington, editor of the 'Index Medicus,' to celebrate the revival of its publication.

Mr. H. F. Perkins, of the University of Vermont, has been given a research assistantship by the Carnegie Institution for study of special organs and structure of jelly-fish which affect their distribution.

Professor Charles S. Sargent, director of the Arnold Aboretum, Harvard University, will spend next year abroad, devoting a part of the time to studying the trees of Siberia.

Dr. W. A. Setchell, professor of botany in the University of California, has been given a year's leave of absence which he will spend in Europe.

M. E. Jaffa, assistant professor of agriculture in the University of California, who has for the present year been carrying on studies in nutrition in conjunction with Professor W. O. Atwater, has gone to Europe to visit the centers where similar work is in progress.

The National Geographic Society has appointed Mr. William J. Peters, of the U. S. Geological Survey, as its representative on the Arctic expedition to be sent by Mr. William Ziegler. Mr. Peters will be second in com-

mand of the expedition, as well as director of the scientific observations.

THE Russian Geographical Society will send a scientific expedition into Mesopotamia during the year. The expedition will be under the leadership of M. Kaznakoff, and will include among its members M. Alferaki, the zoologist, and M. Tolmatcheff, the geologist.

M. LACROIX, sent by the Paris Academy of Sciences to Martinique, has returned to Paris, after six months spent in studying the conditions on the island.

MR. JONATHAN HUTCHINSON has returned from India, where he has been investigating the cause of leprosy.

A WINDOW in honor of Horace Wells, the discoverer of anesthesia, has been placed in the First Congregational Church at Hartford, Conn., by his son, Mr. Charles T. Wells. The cartoon was designed by Mr. Frederick Wilson and executed by the Tiffany Company, New York City.

PAUL BELLONI DU CHAILLU, the explorer and author, died at St. Petersburg on April 29. He was born in New Orleans in 1838, and in 1855 he went from New York to the west coast of Africa, where he made the well-known expedition described in his 'Explorations and Adventures in Equatorial Africa.'

The death is announced of M. E. Duporcq, secretary of the French Mathematical Society, at the age of thirty-one years.

THE American Medical Association is meeting this week at New Orleans under the presidency of Dr. Frank Billings.

THE American Social Science Association meets in Boston on May 14, 15 and 16. Sessions are to be devoted to the discussion of public health and education in physiology and hygiene, the speakers including Professor W. T. Sedgwick, Dr. W. T. Councilman and Dr. E. M. Hartwell.

*The Medical Record* and *The Medical News* publish cable reports of the fourteenth international Medical Congress, which met at Madrid last week. On the first day five thousand delegates were registered, proportioned as follows: Germany and Austria, 1,000; France, 825; Great Britain, 235; Russia, 290; Italy, 335; other European countries, 327; United States, 193; South America, 136. The Moscow prize for original research, established by the city of Moscow, in honor of the meeting of the Congress in that city in 1897, was awarded to Professor Metchnikoff, and that of Paris to Professor Grassi. It is expected that the next congress will be at Buda Pesth. No discoveries of an epoch-making character appear to have been presented to the congress, though the programs are said to contain the titles of many papers of importance.

THE Boston *Transcript* states that a bill has been favorably reported to the Connecticut General Assembly providing for the establishment of a geological and natural history survey of the State. The work is to be conducted under a commission composed of the governor, the presidents of Yale and Wesleyan Universities, of Trinity College and of the Connecticut Agricultural College. The commission is to serve without compensation except for necessary expenses. It is directed to appoint as superintendent of the survey a scientist of established reputation and such assistants as may be deemed necessary. The bill carries an appropriation of $3,000. The objects of the survey as explained in the bill are as follows: First, an examination of the geological formations of the State with special reference to their economic products, namely, building stones, clays, ores and other mineral substances; second, an examination of the animal and plant life of the State with special reference to its economic and educational value; third, the preparation of special maps to illustrate the resources of the State; and fourth, the preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and a detailed description of the geology and natural history of the State. It is expected that the bill will pass without opposition.

*Nature* states that the French Physical Society has held its annual exhibition of apparatus in Paris. The entrance hall and vestibule were lighted with 'heliophone' lamps of the French Incandescent Gas Company, the stair-

case and ground floor by the French Oxyhydrogen Company, and the entrance hall of the first floor by Nernst lamps. Conferences were held in the Physics Theatre of the Faculty of Sciences on April 16, 17 and 18, at which the following papers were read:—'On Anomalous Propagation of the Form of Vibrations in the Neighborhood of a Focus,' by M. G. Sagnac; 'Recent Researches in Radioactivity,' by M. P. Curie; 'Experiments on Electric Convection,' by MM. Crémieu and Pender; and 'Further Experiments on Electric Convection,' by M. Vasilesco Karpen.

Reuter's Agency states that Sir Alfred Jones, chairman of the Liverpool School of Tropical Medicine, has received the following communication from the expedition sent by the school to the Gambia and Senegambia to investigate the newly-discovered parasite of trypanasoma. The report is dated March 18, and comes from McCarthy Island, 150 miles in the interior of the Gambia. The communication says: "We have just returned from a trip, taking nearly two weeks, to Maka, the chief town of the French 'Cercle de Niani-Ouli.' While there we stayed with M. Porthes, the French Commandant of that district, who was very kind to us in every way. Maka is situated about sixteen miles from the head of Kunchau creek, and about twice that distance from the main river. Our object in going there was to examine the natives living in the interior and away from large collections of water. Although we found the parasite in none of the natives examined, we did find a trypanasome in each of two horses belonging to the Commandant, which he believes to have become infected while in the district far up the river beyond the British possessions. We are hoping that there is something in this, and intend to experiment at St. Louis (French territory), as many horses there are said to suffer from a species of 'malaria,' and die from it. We hope to be able to show that it is trypanasoma, the symptoms, as far as we can see at present, being the same as those developed in the two horses seen at Maka. This will be of great importance to the French government in Senegal if correct. If it is at all possible, Dr. Todd intends leaving for this district within the next two days. At present we intend to leave the Gambia by the *Benin*, which is due at Bathurst on the 7th of next month. From Dakar we shall go straight to St. Louis, where, unless something important turns up, we shall only stay for a fortnight before returning to Dakar to catch the steamer for Conakry. We recently infected a horse with the human trypanasome. Only two days ago we found numerous trypanasomes in its blood, and in the stomach of a species of horn fly (which is rather troublesome here) which had fed on this horse we found interesting forms of the parasites suggesting conjugation."

At the recent meeting of the Michigan Academy of Science, at Ann Arbor, the two following resolutions were adopted:

(1) Whereas, The contour topographic map of the Ann Arbor quadrangle, recently completed by the United States Geographical Survey in cooperation with the Geological Survey of Michigan, is of a high degree of excellence; and

Whereas, A similar map of the entire area of Michigan, in addition to its direct commercial and educational importance, would be of great assistance in many branches of scientific research:

*Resolved,* That the request now before the legislature for an addition of $1,000 to the appropriation for the State Geological Survey, to enable it to continue to cooperate with the United States Geological Survey in making a topographical survey and contour topographic map of Michigan, is heartily approved, and the prompt passage of the measure referred to earnestly desired.

(2) Whereas, The sanitary science section of this academy has considered the subject of the proposed establishment of state sanatoria for consumptives, and it has been learned by scientific methods that such sanatoria, in other states and countries are efficient for the education and care of consumptives; therefore,

*Resolved,* That this academy respectfully petition the legislature of Michigan to establish at least one state sanatorium for the education and care of consumptives, and that an

adequate appropriation be made for that purpose.

*Nature* states that the Naples Academy of Physical and Mathematical Sciences offers a prize of 1000 lire to the author of the best memoir on the theory of the invariants of the ternary biquadratic form, preferably in connection with the conditions for splitting into lower form. The papers may be written in Italian, Latin or French, and must be sent in on or before June 30, 1904. In addition prizes are offered in connection with the legacy of Professor Luigi Sementini, who in 1847 left the sum of 150 ducats per annum 'to distribute it as a prize for three memoirs on applied chemistry which they shall judge the best, or to award it as a prize to the author of one single memoir containing great utility, or finally to give it as a life pension to the author of a classical discovery useful to sick mankind.' Competitors for this prize are invited to send in their applications, accompanied by manuscript or printed papers, not later than December 31, 1903.

MR. NEVILLE-ROLFE, British consul in Naples, refers in a report abstracted in the London *Times* to the widespread interest now being taken in Italy in the question of re-afforesting the country. In 1877 about four millions of acres were withdrawn from the operation of the old forest laws, as well as about one million acres in Sicily and Sardinia. The consequence was a reckless destruction of forests; and now it is generally admitted that the state must step in to save those that are left and to aid in replanting. The question now being discussed is what trees are to be used for the latter purpose. The Italian oak is of little use except for railway sleepers; there is plenty of chestnut all over the country, and pine-trees would grow luxuriantly and prove most useful. The cork-tree, however, appears to be the one which would prove economically the most valuable, and it has hitherto been almost wholly neglected in Italy. In 1900 the cork exported was valued at only £36,000, and much, no doubt, was used at home. But a few years ago Spain exported wine corks to the value of over a million sterling. In Italy about 80,000 hectares of land are under the cork-tree, chiefly in Sicily and Sardinia; in Portugal, Spain and Algeria the areas respectively are 300,000, 250,000 and 281,000 hectares. The Calabrian cork forests have been almost wholly destroyed, the trees having been burnt for charcoal, and even Sicily now imports corkwood in considerable quantities. Seventy years ago nearly all the cork imported into England went from Italy. But since then most of the Italian forests have been destroyed for charcoal and to produce potash, and those that remain are being devastated for the same purpose; and no one thinks of replanting the ground, which naturally gets washed away owing to the absence of trees. Large forests containing a majority of cork-trees are continually being released from the forests laws, and there is a risk that the production of cork in Italy will soon cease. Nothing can replace cork in its manifold use, and now when vast quantities are used in making linoleum and in shipbuilding an adequate supply of it is of great economical importance.

## UNIVERSITY AND EDUCATIONAL NEWS.

THE board of trustees of Stanford University held a meeting on April 25, at which the formal transfer of the property of the university to the trustees was considered. It is understood that the transfer will be made during the present week. Mrs. Stanford will be elected president of the board of trustees.

THE New Hampshire legislature has voted an appropriation of $20,000 a year for two years to Dartmouth College.

AMONG the appropriations made by the state legislature to the University of Missouri there is one of $7,500 for an addition to the new building occupied by botany, entomology and horticulture. The addition will be used for experimental work in botany along physiological, pathological and ecological lines.

MR. ANDREW CARNEGIE has contributed $12,000 toward the amount needed for the erection of Emerson Hall, the new philosophical building of which Harvard University hopes to lay the corner-stone on May 25, the centennial anniversary of Ralph Waldo Emerson's birth.

This gift was made through Professor Münsterberg, and it brings the total amount now subscribed for this building up to about $140,000, or within $10,000 of the total which the university corporation requires before it will permit the corner-stone to be laid.

The new engineering building being erected at Brown University for the immediate use of the departments of Mechanical Engineering and Drawing will be ready for occupany next September. The building is 72 by 84 feet, three stories high, and is designed so that a later addition of nearly equal size may be made to provide room for all the engineering departments.

The Technical Education Board of the London County Council is offering for competition five senior county scholarships, together with a certain number of senior exhibitions. The scholarships are of the value of £90 a year, and are tenable, under ordinary circumstances, for three years at universities, university colleges or technical institutes, whether at home or abroad.

The board of governors of McGill University have decided that the faculty of comparative medicine and veterinary science at the university shall cease to exist at the close of the present session. The reason given for this step is the impossibility of securing adequate funds for the reorganization of the faculty along the lines suggested by the governing staff of the university.

N. M. Fenneman, professor of geology at the University of Colorado and C. K. Leith, assistant professor of geology at the University of Wisconsin, have been appointed professors of geology in the latter university in view of the election of Professor C. R. Van Hise to the presidency.

At the annual meeting of the regents of the University of Nebraska on April 24 and 25, Frank G. Miller, of the Yale School of Forestry, was elected professor of forestry, his services to begin September next. The following promotions in scientific positions were announced: H. R. Smith, from associate professor of animal husbandry to professor of animal husbandry; J. H. Gain, from instructor in animal pathology, to adjunct professor of animal pathology; F. E. Clements, from adjunct professor of botany to assistant professor of botany; G. H. Chatburn, from adjunct professor of mathematics and civil engineering to assistant professor of civil engineering; A. L. Haecker, from assistant professor of dairy husbandry to associate professor of dairy husbandry; F. W. Smith, from instructor in education to adjunct professor of education; R. A. Emerson, from assistant professor of horticulture to associate professor of horticulture; A. L. Candy, from adjunct professor of mathematics to assistant professor of mathematics; R. E. Moritz, from adjunct professor of mathematics to assistant professor of mathematics; C. C. Engberg, from instructor in mathematics to adjunct professor of mathematics; T. L. Bolton, from adjunct professor of philosophy to assistant professor of philosophy; C. A. Skinner, from adjunct professor of physics to assistant professor of physics; R. H. Wolcott, from assistant professor of zoology to associate professor of zoology; W. A. Willard, from instructor in zoology to adjunct professor of zoology; G. H. Morse, from associate professor of electrical engineering to professor of electrical engineering. Among other appointments are the following: H. H. Waite, to be assistant professor of bacteriology and pathology; H. L. Shantz, to be instructor in botany; R. S. Lillie, to be adjunct professor of physiology. Fellowships were announced as follows: G. G. Frary, chemistry; H. L. Shantz, botany; Esther P. Hensel, botany. G. F. Miles was announced as scholar in botany.

Among the members of the summer school of the University of California from other institutions will be Professor Palmer, of Harvard, in ethics, Professor Angell, of Chicago, in psychology, Professor Monroe, of Columbia, in educational method, Professor Palache, of Harvard, in mineralogy, and Mr. Gifford Pinchot, chief of the Bureau of Forestry.

Norton A. Kent, Ph.D., formerly assistant at Yerkes Observatory, is at present in charge of the department of physics at Wabash College, Crawfordsville, Indiana.